United States Department of Agriculture

Soil Conservation Service

In cooperation with North Dakota Agricultural Experiment Station, North Dakota Cooperative Extension Service, and North Dakota State Soil Conservation Committee

Soil Survey of Foster County, North Dakota

How To Use This Soil Survey

General Soil Map

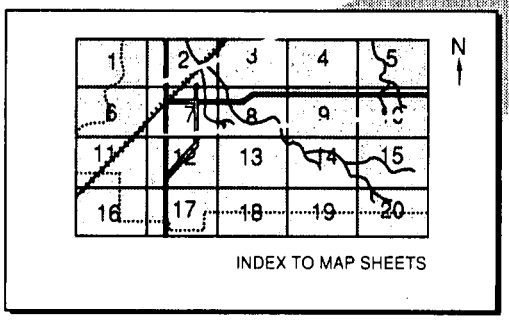
The general soil map, which is the color map preceding the detailed soil maps, shows the survey area divided into groups of associated soils called general soil map units. This map is useful in planning the use and management of large areas.

To find information about your area of interest, locate that area on the map, identify the name of the map unit in the area on the color-coded map legend, then refer to the section **General Soil Map Units** for a general description of the soils in your area.

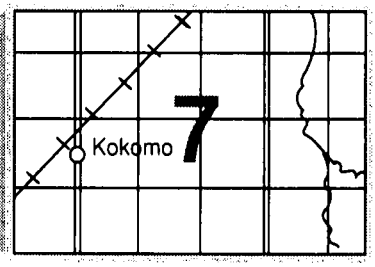
Detailed Soil Maps

The detailed soil maps follow the general soil map. These maps can be useful in planning the use and management of small areas.

To find information about your area of interest, locate that area on the **Index to Map Sheets**, which precedes the soil maps. Note the number of the map sheet, and turn to that sheet.



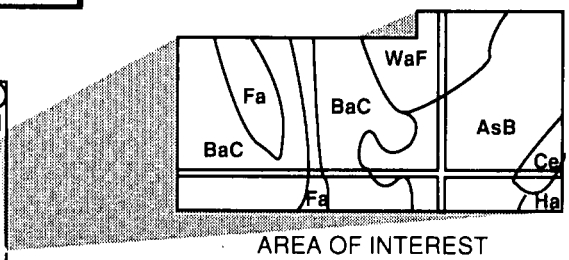
INDEX TO MAP SHEETS



MAP SHEET

Locate your area of interest on the map sheet. Note the map unit symbols that are in that area. Turn to the **Index to Map Units** (see Contents), which lists the map units by symbol and name and shows the page where each map unit is described.

MAP SHEET



AREA OF INTEREST

NOTE: Map unit symbols in a soil survey may consist only of numbers or letters, or they may be a combination of numbers and letters.

The **Summary of Tables** shows which table has data on a specific land use for each detailed soil map unit. See **Contents** for sections of this publication that may address your specific needs.

This soil survey is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Soil Conservation Service has leadership for the Federal part of the National Cooperative Soil Survey.

Major fieldwork for this soil survey was completed in 1990. Soil names and descriptions were approved in 1990. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1990. The flight for the photo base was in 1978. This survey was made cooperatively by the Soil Conservation Service, the North Dakota Agricultural Experiment Station, the North Dakota Cooperative Extension Service, and the North Dakota State Soil Conservation Committee. It is part of the technical assistance furnished to the Foster County Soil Conservation District. Financial assistance was provided by the Foster County Board of Commissioners and the North Dakota Department of University and School Lands.

All programs and services of the Soil Conservation Service are offered on a nondiscriminatory basis, without regard to race, color, national origin, religion, sex, age, marital status, or handicap.

Cover: An area of Helmdal and Emrick soils where a farmstead is protected by windbreaks. The circular area is an area of Parnell soils. The hilly and steep Esmond and Helmdal soils in the background are used for range. The contrast along the fence line in the background is a result of differing range management.

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Issued July 1995

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Summary of Tables

Foreword

This soil survey contains information that can be used in land-planning programs in Foster County. It contains predictions of soil behavior for selected land uses. The survey also highlights limitations and hazards inherent in the soil, improvements needed to overcome the limitations, and the impact of selected land uses on the environment.

This soil survey is designed for many different users. Farmers, ranchers, foresters, and agronomists can use it to evaluate the potential of the soil and the management needed for maximum food and fiber production. Planners, community officials, engineers, developers, builders, and home buyers can use the survey to plan land use, select sites for construction, and identify special practices needed to ensure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the survey to help them understand, protect, and enhance the environment.

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are shallow to bedrock. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map. The location of each soil is shown on the detailed soil maps. Each soil in the survey area is described. Information on specific uses is given for each soil. Help in using this publication and additional information are available at the local office of the Soil Conservation Service or the Cooperative Extension Service.

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Soil Survey of Foster County, North Dakota

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Map finishing by Steven S. Kranich, North Dakota State Conservation Committee, and Juan Ramirez and Jerri Settelmeyer, Soil Conservation Service

United States Department of Agriculture, Soil Conservation Service, in cooperation with the North Dakota Agricultural Experiment Station, the North Dakota Cooperative Extension Service, and the North Dakota State Soil Conservation Committee

FOSTER COUNTY is in the east-central part of North Dakota (fig. 1). It has a total area of 413,900 acres. The county is bounded on the south by Stutsman County, on the west by Wells County, on the north by Eddy County, and on the east by Griggs County. The county seat is Carrington, which is in the west-central part of the county.

The county is in the Northern Dark Brown Glaciated Plains portion of the Northern Great Plains Spring Wheat Region *(14)*.

The first soil survey of part of Foster County, the Carrington area, was published in 1906 *(8)*. A general soil map of the county was published in 1963 and was described in a report published in 1968 *(10)*. A general soil map and report published in 1968 *(9)* also included information about Foster County. The present soil survey updates the earlier reports. It provides additional information and generally shows the soils in more detail.

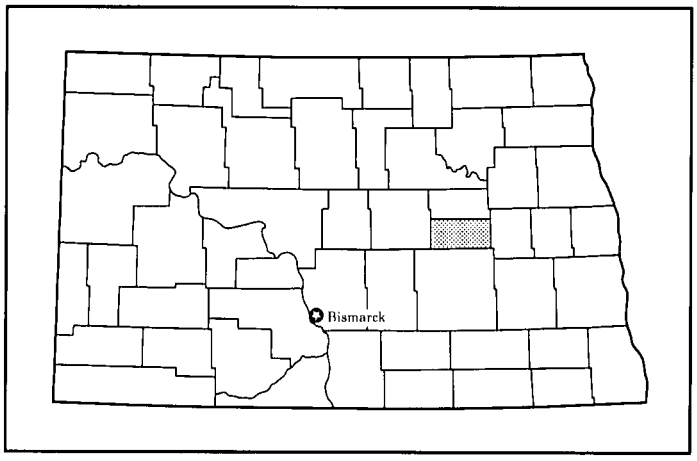

Figure 1.—Location of Foster County in North Dakota.

General Nature of the County

This section provides general information about Foster County. It describes climate; physiography, relief, and drainage; water supply; and transportation facilities.

Climate

Foster County is usually quite warm in summer. It has frequent spells of hot weather and occasional cool days. It is very cold in winter, when arctic air frequently surges over the survey area. Precipitation occurs mainly during the warm period and is normally heaviest in late

spring and early summer. Winter snowfall is generally not too heavy, and it is blown into drifts, so that much of the ground is free of snow. Several times each winter, storms with snow and high winds bring blizzard conditions to the survey area. Hail falls in scattered, small areas during summer thunderstorms.

Table 1 gives data on temperature and precipitation for the survey area as recorded at Carrington in the period 1951 to 1987. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

In winter, the average temperature is 10 degrees F and the average daily minimum temperature is -2 degrees. The lowest temperature on record, which occurred at Carrington on January 29, 1966, is -34 degrees. In summer, the average temperature is 66 degrees and the average daily maximum temperature is 78 degrees. The highest recorded temperature, which occurred on July 12, 1973, is 107 degrees.

Growing degree days are shown in table 1. They are equivalent to "heat units." During the month, growing degree days accumulate by the amount that the average temperature each day exceeds a base temperature (40 degrees F). The normal monthly accumulation is used to schedule single or successive plantings of a crop between the last freeze in spring and the first freeze in fall.

The total annual precipitation is about 18 inches. Of this, more than 14 inches, or about 77 percent, usually falls in April through September. The growing season for most crops falls within this period. In 2 years out of 10, the rainfall in April through September is less than 11 inches. The heaviest 1-day rainfall during the period of record was 3.45 inches at Carrington on July 18, 1987. Thunderstorms occur on about 34 days each year.

The average seasonal snowfall is about 41 inches. The greatest snow depth at any one time during the period of record was 34 inches. On the average, 60 days of the year have at least 1 inch of snow on the ground. The number of such days varies greatly from year to year.

The average relative humidity in midafternoon is about 55 percent. Humidity is higher at night, and the average at dawn is about 80 percent. The sun shines 70 percent of the time possible in summer and 50 percent in winter. The prevailing wind is from the west-northwest. Average windspeed is highest, 12 miles per hour, in spring.

Physiography, Relief, and Drainage

Nearly all of Foster County is within the Drift Plains district of the Central Lowland province. A very small part in the southwest corner is in the Missouri Coteau district of the Great Plains province *(5)*. The area in the Drift Plains district is characterized by flat to gently rolling topography that is rough on the four end moraines and smoother on the ground moraines and outwash plains. The landscape in the Missouri Coteau district is characterized by a hilly surface on a dead ice moraine.

The James River, an intermittent stream, flows through the county in a southerly direction. It is entrenched as much as 100 feet and is generally less than one-tenth mile wide. Kelly Creek is a tributary of the James River *(5)*. Much of the surface water flows to lakes and to natural wetlands. Water from a narrow area adjacent to Kelly Creek and the James River flows to those streams (fig. 2).

Water Supply

The major sources of water in the county are aquifers, lakes, rivers, and individual wells. The major aquifers in the county are the Spiritwood, Johnson Lake, Eastman, James River, New Rockford, Carrington, Russell Lake, and Pipestem Creek aquifers. About 20 percent of the county is underlain by aquifers capable of yielding 50 gallons of water per minute to individual wells. The New Rockford and Carrington aquifers probably have the greatest potential as a source of water. Yields in the Carrington aquifer are as high as 1,000 gallons of water per minute. The potential yields from the New Rockford aquifer are similar. The water is generally hard. The water from bedrock aquifers is generally saline *(11)*.

Transportation Facilities

The major north-south route in the county is U.S. Highway 281. The main east-west routes are U.S. Highway 52 and North Dakota Highway 200. These highways and the paved county and township roads provide a good farm-to-market transportation system. Railroads cross the southwestern and the northwestern parts of the county. The nearest airline service is at Devils Lake, which is about 50 miles north of Carrington.

How This Survey Was Made

This survey was made to provide information about the soils in the survey area. The information includes a description of the soils and their location and a discussion of the suitability, limitations, and management of the soils for specified uses. Soil scientists observed the steepness, length, and shape of

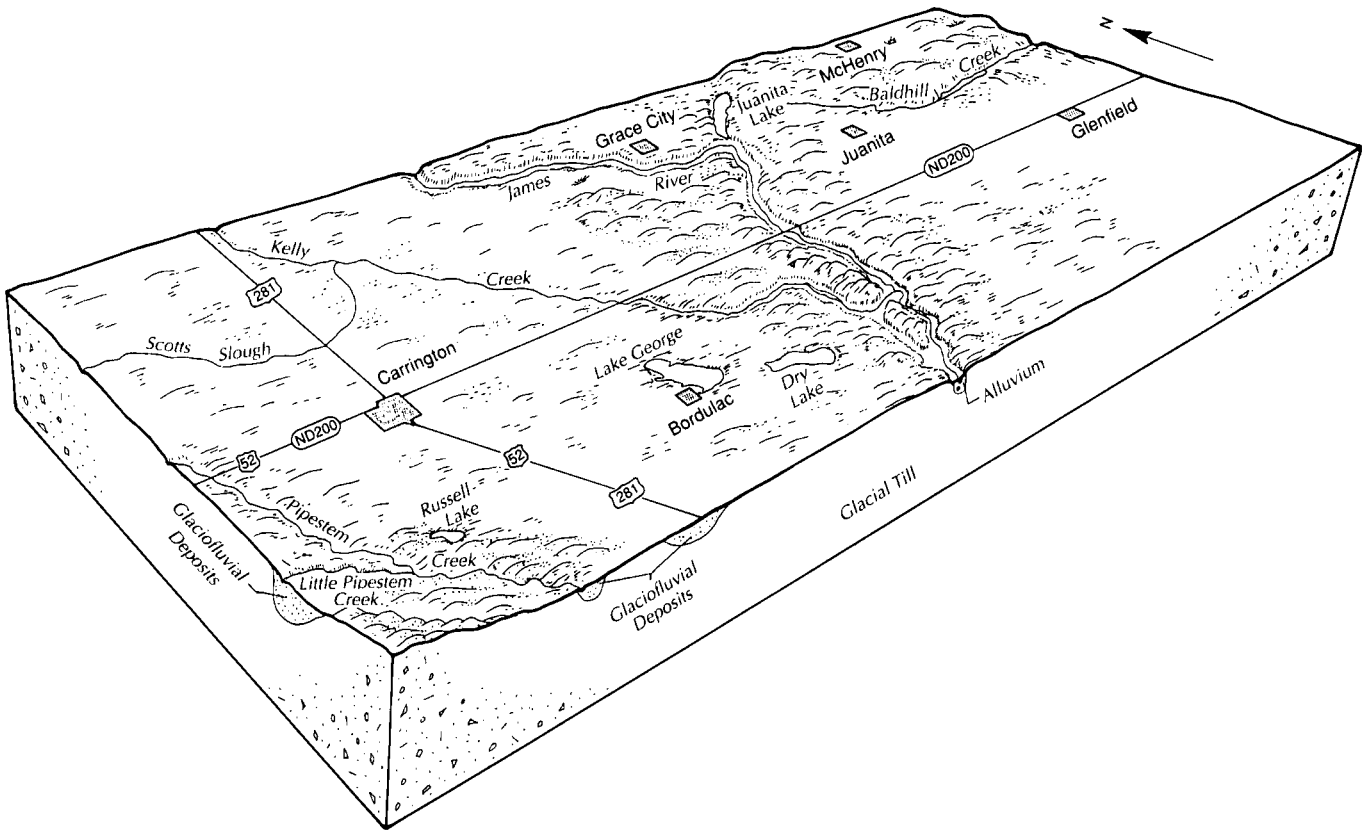

Figure 2.—Physiographic features of Foster County, North Dakota.

slopes; the general pattern of drainage; the kinds of crops and native plants growing on the soils; and the kinds of bedrock. They dug many holes to study the soil profile, which is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

The soils in the survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil is associated with a particular kind of landscape or with a segment of the landscape. By observing the soils in the survey area and relating their position to specific segments of the landscape, a soil scientist develops a concept, or model, of how the soils were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. The system of taxonomic classification

used in the United States is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot assure that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Map Unit Composition

A map unit delineation on a soil map represents an area dominated by one major kind of soil or an area dominated by two or three kinds of soil. A map unit is identified and named according to the taxonomic classification of the dominant soil or soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural objects. In common with other natural objects, they have a characteristic variability in their properties. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of soils of other taxonomic classes. Consequently, every map unit is made up of the soil or soils for which it is named and some soils that belong to other taxonomic classes. These latter soils are called inclusions or included soils.

Most inclusions have properties and behavioral patterns similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting (similar) inclusions. They may or may not be mentioned in the map unit descriptions. Other inclusions, however, have properties and behavior divergent enough to affect use or require different management. These are contrasting (dissimilar) inclusions. They generally occupy small areas and cannot be shown separately on the soil maps because of the scale used in mapping. The inclusions of contrasting soils are mentioned in the map unit descriptions. A few inclusions may not have been observed and consequently are not mentioned in the descriptions, especially where the soil pattern was so complex that it was impractical to make enough observations to identify all of the kinds of soil on the landscape.

The presence of inclusions in a map unit in no way diminishes the usefulness or accuracy of the soil data. The objective of soil mapping is not to delineate pure taxonomic classes of soils but rather to separate the landscape into segments that have similar use and management requirements. The delineation of such landscape segments on the map provides sufficient information for the development of resource plans, but onsite investigation is needed to plan for intensive uses in small areas.

Survey Procedures

The general procedures used to make this survey are described in the "National Soil Survey Handbook" of the Soil Conservation Service and the "Soil Survey Manual" *(15)*. The "Major Soils of North Dakota" *(9)*, "Soil Taxonomy" *(13)*, and "Land Resource Regions and Major Land Resource Areas of the United States" *(14)* were among the references used. The procedures used in determining the nature and characteristics of the soils are described under the heading "How This Survey Was Made."

Soil scientists traversed the land on foot and by pickup or an all-terrain vehicle at an interval close

enough for them to locate contrasting soil areas of about 3 to 5 acres. All map units were characterized by transects of representative areas. Generally, one transect was recorded for each 1,000 acres of a given map unit.

Data collected from the transects were used to determine soil names and establish the range of composition of each map unit. A statistical method was used *(3)*. This statistical analysis indicates that the map unit composition given in the descriptions is at least 90 percent accurate.

Each map unit was documented by at least one pedon description for each soil series identified in its name. Laboratory data were collected in 1986 and 1988 on eight pedons sampled for engineering properties. The analyses were made by the North Dakota State Highway Department.

General Soil Map Units

The general soil map at the back of this publication shows the soil associations in this survey area. Each association has a distinctive pattern of soils, relief, and drainage. Each is a unique natural landscape. Typically, an association consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one association can occur in another but in a different pattern.

The general soil map can be used to compare the suitability of large areas for general land uses. Areas of suitable soils can be identified on the map. Likewise, areas where the soils are not suitable can be identified.

Because of its small scale, the map is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The soils in any one association differ from place to place in slope, depth, drainage, and other characteristics that affect management.

As a result of changes in series concepts, the location of moisture regime areas, differing soil patterns, and differences in the design of the associations, some of the soil boundaries and soil names on the general soil map of this county do not match those on the maps of Eddy, Griggs, Stutsman, and Wells Counties, North Dakota.

Soil Descriptions

Dominantly Level to Rolling, Loamy Soils

These soils formed in glacial till on till plains. They make up about 70 percent of the county. Most areas are used as cropland. Most of the soils are suited to cultivated crops, pasture, and range. The rolling Buse and Esmond soils are best suited to pasture or range. The main concern in managing cultivated areas is controlling soil blowing and water erosion. The main concern in managing pasture and range is maintaining an adequate cover of the important or suitable forage plants.

1. Fram-Heimdal-Emrick Association

Very deep, level to undulating, somewhat poorly drained to well drained, medium textured soils

This association consists of soils on flats and rises and in swales on till plains. In most areas surface water flows into scattered depressions. Slope ranges from 0 to 6 percent.

This association makes up about 24 percent of the county. It is about 40 percent Fram soils, 20 percent Heimdal soils, 15 percent Emrick soils, and 25 percent soils of minor extent (fig. 3).

The level and nearly level, somewhat poorly drained, highly calcareous Fram soils are on rises and flats. Typically, the surface layer is black, calcareous loam about 8 inches thick. The subsoil is calcareous loam about 15 inches thick. It is light brownish gray and mottled in the upper part and light olive brown and grayish brown in the lower part. The substratum to a depth of about 60 inches is olive brown, mottled, calcareous loam.

The level to undulating, well drained Heimdal soils are on rises. Typically, the surface layer is black loam about 7 inches thick. The subsoil is loam about 23 inches thick. It is dark brown in the upper part and light olive brown and calcareous in the lower part. The substratum to a depth of about 60 inches is olive brown, calcareous loam.

The level to undulating, moderately well drained Emrick soils are in swales. Typically, the surface soil is black loam about 16 inches thick. The subsoil is loam about 27 inches thick. It is very dark grayish brown in the upper part and olive brown and calcareous in the lower part. The substratum to a depth of about 60 inches is olive brown, mottled, calcareous loam.

Esmond, Parnell, Tonka, Vallers, and Wyard soils are the principal minor soils in this association. The well drained Esmond soils are on knolls. They have a calcareous subsoil. The very poorly drained Parnell soils and the poorly drained Tonka soils are in

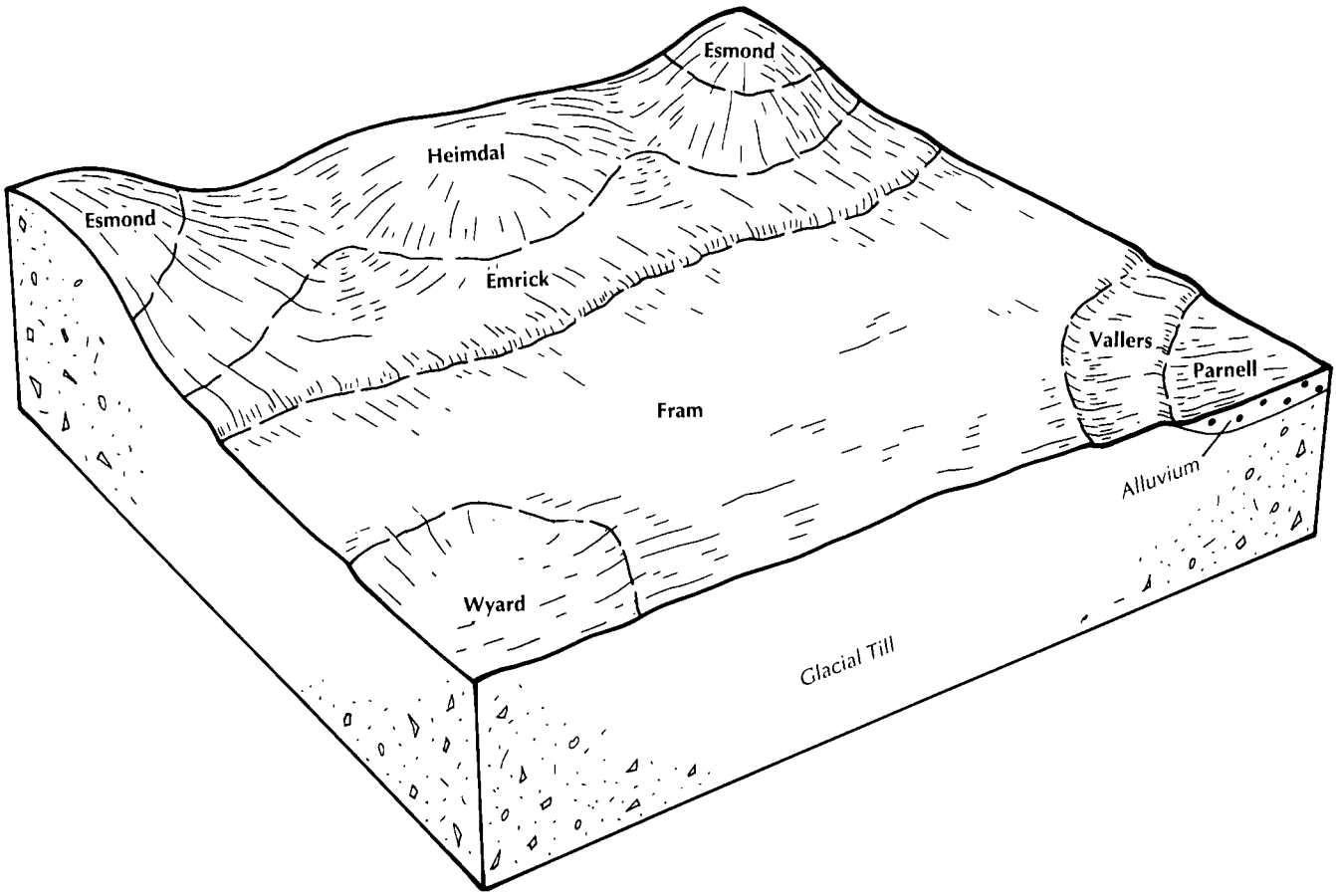

Figure 3.—Typical pattern of soils and parent material in the Fram-Heimdal-Emrick association.

depressions. They have an accumulation of clay in the subsoil. The poorly drained, moderately saline Vallers soils are on flats adjacent to depressions. They have an accumulation of lime within a depth of 16 inches. The somewhat poorly drained Wyard soils are in swales. They have a subsoil that is mottled and noncalcareous in the upper part.

In most areas this association is used for cultivated crops. It is well suited to small grain, sunflowers, and grass-legume hay. The main concerns in managing cultivated areas are controlling soil blowing on the Fram soils and controlling water erosion on all three soils.

2. Heimdal-Emrick Association

Very deep, level to undulating, well drained and moderately well drained, medium textured soils that have less than 18 percent clay in the subsoil

This association consists of soils on flats and rises and in swales on till plains. In most areas surface water flows into scattered depressions. Slope ranges from 0 to 6 percent.

This association makes up about 5 percent of the county. It is about 50 percent Heimdal soils, 30 percent Emrick soils, and 20 percent soils of minor extent.

The level to undulating, well drained Heimdal soils are on rises and flats. Typically, the surface layer is black loam about 7 inches thick. The subsoil is loam about 23 inches thick. It is dark brown in the upper part and light olive brown and calcareous in the lower part. The substratum to a depth of about 60 inches is olive brown, calcareous loam.

The level to undulating, moderately well drained Emrick soils are in swales. Typically, the surface soil is black loam about 16 inches thick. The subsoil is loam about 27 inches thick. It is very dark grayish brown in the upper part and olive brown and calcareous in the lower part. The substratum to a depth of about 60 inches is olive brown, mottled, calcareous loam.

Esmond, Fram, and Tonka soils are the principal

minor soils in this association. The well drained Esmond soils are on knolls. They have a calcareous subsoil. The somewhat poorly drained Fram soils are on flats around depressions. They have an accumulation of lime within a depth of 16 inches. The poorly drained Tonka soils are in depressions. They have an accumulation of clay in the subsoil.

In most areas this association is used for cultivated crops. It is well suited to small grain, sunflowers, and grass-legume hay. The main concern in managing cultivated areas is controlling water erosion.

3. Heimdal-Emrick-Esmond Association

Very deep, undulating to rolling, well drained and moderately well drained, medium textured soils that have less than 18 percent clay in the subsoil

This association consists of soils on knolls and rises and in swales on till plains. In most areas surface water flows into scattered depressions. Slope ranges from 3 to 15 percent.

This association makes up about 7 percent of the county. It is about 30 percent Heimdal soils, 25 percent Emrick soils, 25 percent Esmond soils, and 20 percent soils of minor extent.

The undulating to rolling, well drained Heimdal soils are on rises. Typically, the surface layer is black loam about 7 inches thick. The subsoil is loam about 23 inches thick. It is dark brown in the upper part and light olive brown and calcareous in the lower part. The substratum to a depth of about 60 inches is olive brown, calcareous loam.

The undulating, moderately well drained Emrick soils are in swales. Typically, the surface soil is black loam about 16 inches thick. The subsoil is loam about 27 inches thick. It is very dark grayish brown in the upper part and olive brown and calcareous in the lower part. The substratum to a depth of about 60 inches is olive brown, mottled, calcareous loam.

The undulating to rolling, well drained Esmond soils are on knolls. Typically, the surface layer is black, calcareous loam about 7 inches thick. The subsoil is dark grayish brown, calcareous loam about 4 inches thick. The substratum to a depth of about 60 inches is olive brown, calcareous loam.

Fram, Parnell, and Southam soils are the principal minor soils in this association. The somewhat poorly drained Fram soils are on flats around depressions. They have an accumulation of lime within a depth of 16 inches. The very poorly drained Parnell and Southam soils are in depressions. Parnell soils have an accumulation of clay in the subsoil. Southam soils are calcareous throughout.

In most areas this association is used for cultivated crops. In a few areas it is used for range. It is suited to small grain, sunflowers, and grass-legume hay. The rolling Esmond soils are better suited to range and pasture because of the slope and the susceptibility to water erosion and soil blowing. The main concern in managing cultivated areas is controlling water erosion and soil blowing.

4. Hamerly-Svea Association

Very deep, level to undulating, somewhat poorly drained and moderately well drained, medium textured soils

This association consists of soils on flats and rises and in swales on till plains. In most areas surface water flows into scattered depressions. Slope ranges from 0 to 6 percent.

This association makes up about 24 percent of the county. It is about 45 percent Hamerly soils, 25 percent Svea soils, and 30 percent soils of minor extent.

The level and nearly level, somewhat poorly drained Hamerly soils are on rises and flats. Typically, the surface layer is black, calcareous loam about 9 inches thick. The subsoil is calcareous loam about 21 inches thick. It is dark grayish brown in the upper part and light olive brown in the lower part. The substratum to a depth of about 60 inches is light olive brown, calcareous loam. It is mottled below a depth of about 55 inches.

The level to undulating, moderately well drained Svea soils are in swales. Typically, the surface soil is black loam about 20 inches thick. The subsoil is loam about 12 inches thick. It is very dark grayish brown in the upper part and light yellowish brown and calcareous in the lower part. The substratum to a depth of about 60 inches is olive brown, mottled, calcareous loam.

Barnes, Buse, Parnell, Tonka, Vallers, and Wyard soils are the principal minor soils in this association. The well drained Barnes soils are on rises. They have a subsoil that is noncalcareous in the upper part. The dark color of the surface layer in these soils extends to a depth of 7 to 15 inches. The well drained Buse soils are on knolls. They have a subsoil that is calcareous throughout. The very poorly drained Parnell soils and the poorly drained Tonka soils are in depressions. They have an accumulation of clay in the subsoil. The poorly drained, moderately saline Vallers soils are on flats adjacent to depressions. They have an accumulation of lime within a depth of 16 inches. The somewhat poorly drained Wyard soils are in the lower swales. They have a subsoil that is mottled and noncalcareous in the upper part.

In most areas this association is used for cultivated crops. It is well suited to small grain, sunflowers, and grass-legume hay. The main concerns in managing cultivated areas are controlling soil blowing on the

Hamerly soils and controlling water erosion on the undulating Svea soils.

5. Svea-Barnes Association

Very deep, level to undulating, well drained and moderately well drained, medium textured soils that have more than 18 percent clay in the subsoil

This association consists of soils on flats and rises and in swales on till plains. In most areas surface water flows into scattered depressions. Slope ranges from 0 to 6 percent.

This association makes up about 4 percent of the county. It is about 45 percent Svea soils, 35 percent Barnes soils, and 20 percent soils of minor extent.

The level to undulating, moderately well drained Svea soils are in swales. Typically, the surface soil is black loam about 20 inches thick. The subsoil is loam about 12 inches thick. It is very dark grayish brown in the upper part and light yellowish brown and calcareous in the lower part. The substratum to a depth of about 60 inches is olive brown, mottled, calcareous loam.

The level to undulating, well drained Barnes soils are on flats and rises. Typically, the surface layer is black loam about 9 inches thick. The subsoil is loam about 20 inches thick. It is brown in the upper part and light olive brown and calcareous in the lower part. The next layer is light olive brown, calcareous loam about 14 inches thick. The substratum to a depth of about 60 inches is also light olive brown, calcareous loam.

Buse, Hamerly, and Tonka soils are the principal minor soils in this association. The well drained Buse soils are on knolls. They have a calcareous subsoil. The somewhat poorly drained Hamerly soils are on flats. They have an accumulation of lime within a depth of 16 inches. The poorly drained Tonka soils are in depressions. They have an accumulation of clay in the subsoil.

In most areas this association is used for cultivated crops. It is well suited to small grain, sunflowers, and grass-legume hay. The main concern in managing cultivated areas is controlling water erosion.

6. Barnes-Svea-Buse Association

Very deep, undulating to rolling, well drained and moderately well drained, medium textured soils that have more than 18 percent clay in the subsoil

This association consists of soils on knolls and rises and in swales on till plains. In most areas surface water flows into scattered depressions. Slope ranges from 3 to 15 percent.

This association makes up about 6 percent of the county. It is about 30 percent Barnes soils, 25 percent Svea soils, 25 percent Buse soils, and 20 percent soils of minor extent (fig. 4).

The undulating to rolling, well drained Barnes soils are on rises. Typically, the surface layer is black loam about 9 inches thick. The subsoil is loam about 20 inches thick. It is brown in the upper part and light olive brown and calcareous in the lower part. The next layer is light olive brown, calcareous loam about 14 inches thick. The substratum to a depth of about 60 inches is also light olive brown, calcareous loam.

The undulating, moderately well drained Svea soils are in swales. Typically, the surface soil is black loam about 20 inches thick. The subsoil is loam about 12 inches thick. It is very dark grayish brown in the upper part and light yellowish brown and calcareous in the lower part. The substratum to a depth of about 60 inches is olive brown, mottled, calcareous loam.

The undulating to rolling, well drained Buse soils are on knolls. Typically, the surface layer is very dark gray, calcareous loam about 7 inches thick. The subsoil is light olive brown, calcareous loam about 11 inches thick. The substratum to a depth of about 60 inches is also light olive brown, calcareous loam.

Hamerly, Parnell, Southam, and Vallers soils are the principal minor soils in this association. The somewhat poorly drained Hamerly and the poorly drained Vallers soils are on low flats. They have an accumulation of lime within a depth of 16 inches. The very poorly drained Parnell and Southam soils are in depressions. Parnell soils have an accumulation of clay in the subsoil. Southam soils are calcareous throughout.

In most areas this association is used for cultivated crops. In a few areas it is used for range. It is suited to small grain, sunflowers, and grass-legume hay and to range. The rolling Buse soils are better suited to pasture and range because of the slope and the susceptibility to water erosion and soil blowing. The main concerns in managing cultivated areas are controlling water erosion on all three soils and controlling soil blowing on the Buse soils.

Dominantly Level to Steep, Loamy Soils

These soils formed in glacial till and alluvium on valley side slopes, flood plains, and terraces. They make up about 6 percent of the county. Most areas are used for range, pasture, hay, or wildlife habitat and are suited to these uses. A few areas are used for cultivated crops. The rolling to steep areas are best suited to range. The gently rolling areas are suited to cultivated crops. The wet areas are best suited to wildlife habitat or hayland. The main concerns in managing range and pasture are maintaining an

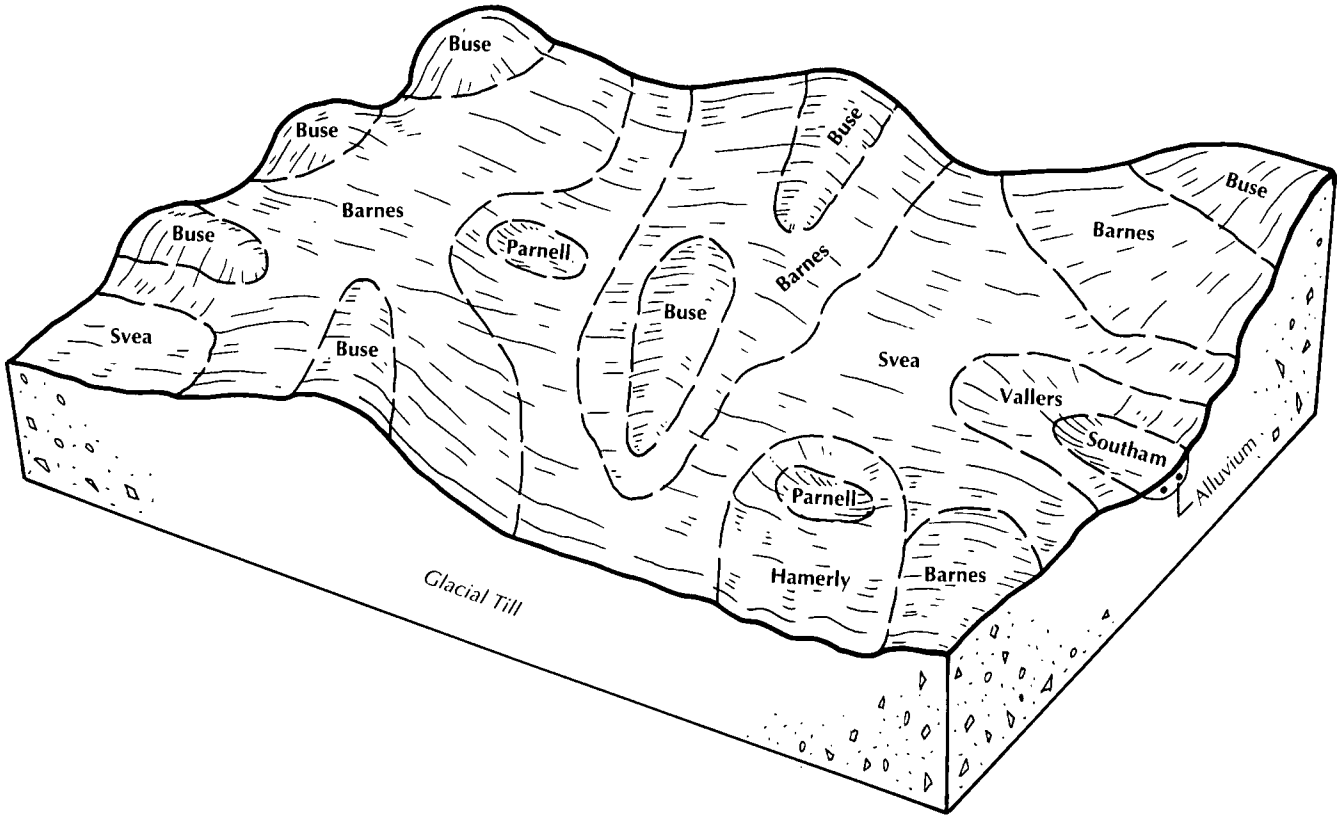

Figure 4.—Typical pattern of soils and parent material in the Barnes-Svea-Buse association.

adequate cover of the important or suitable forage plants and achieving a uniform distribution of grazing. The main concern in managing cultivated areas is controlling water erosion and soil blowing.

7. Heimdal-Esmond-La Prairie Association

Very deep, level to steep, well drained and moderately well drained, medium textured soils

This association consists of soils on flood plains, terraces, and the adjacent valley side slopes. In most areas surface water flows into streams. Slope ranges from 0 to 35 percent.

This association makes up about 5 percent of the county. It is about 35 percent Heimdal soils, 30 percent Esmond soils, 10 percent La Prairie soils, and 25 percent soils of minor extent.

The gently sloping to moderately steep, well drained Heimdal soils are on the lower valley side slopes. Typically, the surface layer is black loam about 7 inches thick. The subsoil is loam about 23 inches thick. It is dark brown in the upper part and light olive brown and calcareous in the lower part. The substratum to a depth of about 60 inches is olive brown, calcareous loam.

The gently sloping to steep, well drained Esmond soils are on the upper valley side slopes. Typically, the surface layer is black, calcareous loam about 7 inches thick. The subsoil is dark grayish brown, calcareous loam about 4 inches thick. The substratum to a depth of about 60 inches is olive brown, calcareous loam.

The level, moderately well drained La Prairie soils are on flood plains and terraces. Typically, the surface soil is loam about 24 inches thick. It is black in the upper part and very dark gray in the lower part. The subsoil is loam about 26 inches thick. It is very dark grayish brown in the upper part and dark brown and calcareous in the lower part. The substratum to a depth of about 60 inches is light olive brown, calcareous loam.

Coe, Colvin, Embden, Emrick, Fram, and Sioux soils are the principal minor soils in this association. The excessively drained Coe soils are on valley side slopes. They have a shaly, gravelly substratum. The poorly drained Colvin soils are on flood plains. They have an accumulation of lime within a depth of 16 inches. The moderately well drained Embden soils are on foot slopes. They have a surface layer and subsoil of fine

sandy loam. The moderately well drained Emrick soils are in swales. The dark color of the surface layer in these soils extends to a depth of more than 16 inches. The somewhat poorly drained Fram soils are on low flats. They have an accumulation of lime within a depth of 16 inches. The excessively drained Sioux soils are on ridges. They have a granitic, gravelly substratum.

In most areas this association is used for range, pasture, hay, or wildlife habitat. In a few areas it is used for cultivated crops. The rolling to steep areas are best suited to range. The undulating and gently rolling areas are suited to cultivated crops. Most of the acreage of the La Prairie soils is dissected into small areas that generally are too small to be used for cultivated crops; however, if the areas are large enough to be cultivated, they are suited to such crops. The main concern in managing range is maintaining an adequate cover of the important native forage plants. The main concern in managing cultivated areas is controlling water erosion.

8. Barnes-Buse Association

Very deep, gently rolling to steep, well drained, medium textured soils

This association consists of soils on rises, ridges, and knolls on moraines. In most areas surface water flows into depressions. Slope ranges from 6 to 35 percent.

This association makes up about 1 percent of the county. It is about 35 percent Barnes soils, 30 percent Buse soils, and 35 percent soils of minor extent.

The gently rolling to hilly Barnes soils are on rises. Typically, the surface layer is black loam about 9 inches thick. The subsoil is loam about 20 inches thick. It is brown in the upper part and light olive brown and calcareous in the lower part. The next layer is light olive brown, calcareous loam about 14 inches thick. The substratum to a depth of about 60 inches is also light olive brown, calcareous loam.

The gently rolling to steep Buse soils are on knolls and ridges. Typically, the surface layer is very dark gray, calcareous loam about 7 inches thick. The subsoil is light olive brown, calcareous loam about 11 inches thick. The substratum to a depth of about 60 inches is also light olive brown, calcareous loam.

Hamerly, Parnell, Sioux, Southam, Svea, and Vallers soils are the principal minor soils in this association. The somewhat poorly drained Hamerly soils are on low flats. They have an accumulation of lime within a depth of 16 inches. The excessively drained Sioux soils are on ridges. They have a granitic, gravelly substratum. The very poorly drained Parnell and Southam soils are in depressions. Parnell soils have an accumulation of clay in the subsoil. The moderately well drained Svea soils are in swales. The dark color of the surface layer in these soils extends to a depth of more than 16 inches. The poorly drained, moderately saline Vallers soils are on low flats adjacent to depressions. They have an accumulation of lime within a depth of 16 inches.

In most areas this association is used as range, pasture, hay, or wildlife habitat. In a few areas it is used for cultivated crops. The rolling to steep areas are best suited to range. The undulating and gently rolling areas are suited to cultivated crops, but these areas are relatively small. The Parnell and Southam soils are best suited to wetland wildlife habitat. The main concern in managing range is maintaining an adequate cover of the important native forage plants. The main concern in managing cultivated areas is controlling water erosion and soil blowing.

Dominantly Level to Undulating, Loamy, Sodic Soils

These soils formed in glacial till on till plains. They make up about 9 percent of the county. Most areas are used for cultivated crops, but some are used for range, pasture, or hay. The soils are suited to cultivated crops. The main concerns in managing cultivated areas are controlling water erosion, improving root penetration in the sodic subsoil, and improving tilth.

9. Cathay-Heimdal-Larson Association

Very deep, level to undulating, well drained to somewhat poorly drained, medium textured soils

This association consists of soils on rises and flats and in swales on till plains. In most areas surface water flows into scattered depressions. Slope ranges from 0 to 6 percent.

This association makes up about 9 percent of the county. It is about 30 percent Cathay soils, 25 percent Heimdal soils, 20 percent Larson soils, and 25 percent soils of minor extent (fig. 5).

The level to undulating, moderately well drained, sodic Cathay soils are on flats and rises. Typically, the surface layer is black loam about 8 inches thick. The subsoil is about 32 inches thick. It is very dark grayish brown clay loam in the upper part; light brownish gray, mottled, calcareous loam in the next part; and olive brown, mottled, calcareous loam in the lower part. The substratum to a depth of about 60 inches is olive brown, mottled, calcareous loam.

The level to undulating, well drained Heimdal soils are on rises. Typically, the surface layer is black loam about 7 inches thick. The subsoil is loam about 23 inches thick. It is dark brown in the upper part and

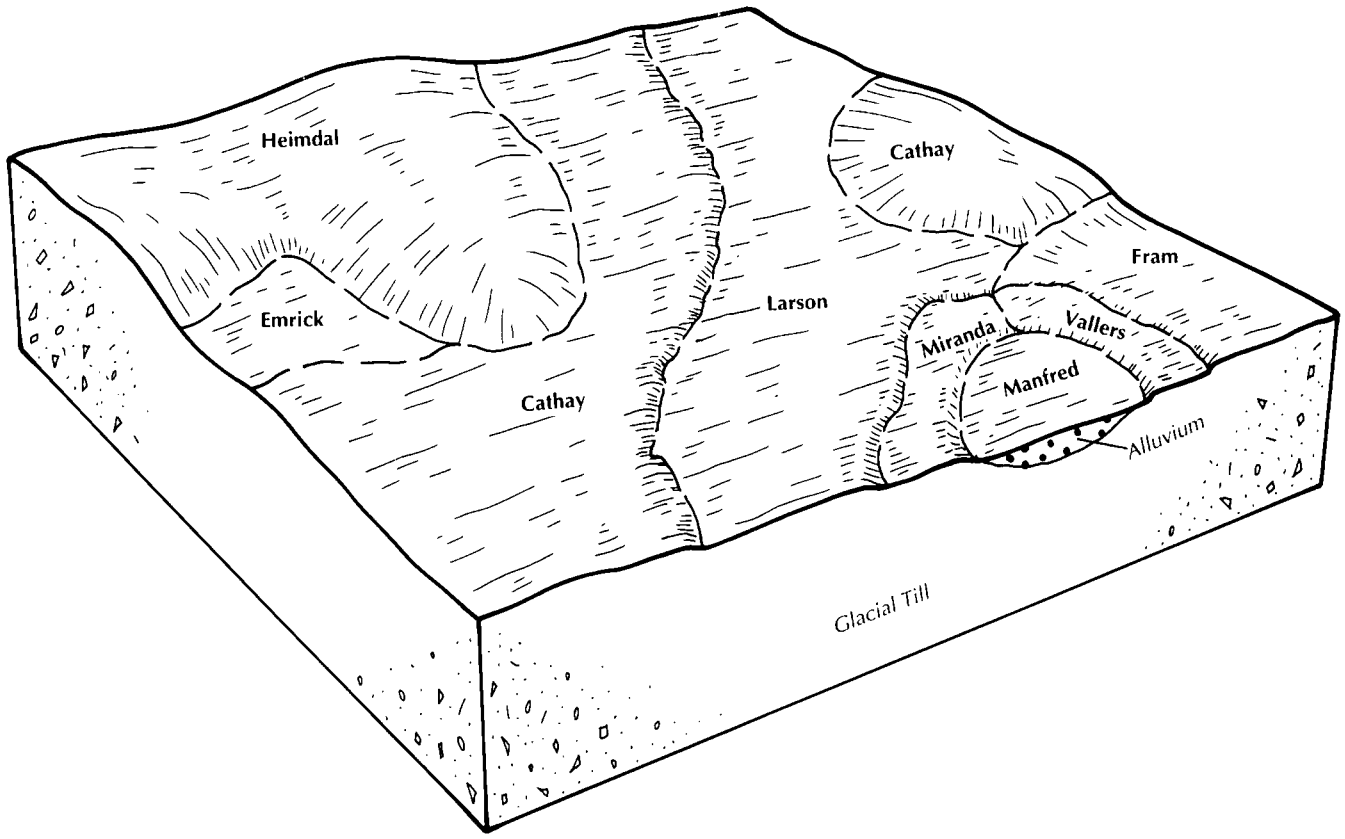

Figure 5.—Typical pattern of soils and parent material in the Cathay-Heimdal-Larson association.

light olive brown and calcareous in the lower part. The substratum to a depth of about 60 inches is olive brown, calcareous loam.

The level and nearly level, somewhat poorly drained, sodic Larson soils are in swales. Typically, the surface layer is black loam about 9 inches thick. The subsurface layer is very dark grayish brown loam about 2 inches thick. The subsoil is about 22 inches thick. It is black clay loam in the upper part and olive brown, mottled, calcareous loam in the lower part. The substratum to a depth of about 60 inches is olive brown, mottled, calcareous clay loam.

Emrick, Esmond, Fram, Letcher, Manfred, Miranda, Southam, and Vallers soils are the principal minor soils in this association. The moderately well drained Emrick soils are in swales. The dark color of the surface layer in these soils extends to a depth of more than 16 inches. The well drained Esmond soils are on knolls. They have a calcareous subsoil. The somewhat poorly drained Fram soils are on low flats. They have an accumulation of lime within a depth of 16 inches. The somewhat poorly drained, sodic Letcher soils are on flats and rises. They have a surface layer and subsoil of fine sandy loam. The poorly drained, sodic Manfred soils are in depressions. The somewhat poorly drained, sodic Miranda soils are on flats and in swales. They have a dense subsoil at a depth of about 4 inches and salts within a depth of 16 inches. The very poorly drained Southam soils are in depressions. They are calcareous throughout. The poorly drained, moderately saline Vallers soils are on low flats adjacent to depressions. They have an accumulation of lime within a depth of 16 inches.

In most areas this association is used for cultivated crops. In some areas it is used for range, pasture, or hay. It is suited to cultivated crops. The main concerns in managing cultivated areas are controlling salinity in all three soils and overcoming the poor tilth of the Cathay and Larson soils.

Dominantly Level to Rolling, Loamy, Sandy, and Silty Soils

These soils formed in glaciolacustrine deposits, glaciofluvial deposits, eolian soil material, glacial till, and alluvium. They are on lake plains, outwash plains, till plains, flood plains, and mantled till plains and lake

plains. They make up about 15 percent of the county. Most areas are used for cultivated crops, but some are used for hay, pasture, or range. Most of the soils are suited to cultivated crops. The main concerns in managing cultivated areas are controlling soil blowing and water erosion and overcoming droughtiness.

10. Barnes-Maddock Association

Very deep, level to rolling, well drained, medium to coarse textured soils

This association consists of soils on rises and flats and in swales on mantled till plains. Surface water flows into scattered depressions or streams. Slope ranges from 0 to 15 percent.

This association makes up about 4 percent of the county. It is about 35 percent Barnes soils, 30 percent Maddock soils, and 35 percent soils of minor extent.

The Barnes soils are on flats and rises. Typically, the surface layer is black loam and sandy loam about 9 inches thick. The subsoil is loam about 20 inches thick. It is brown in the upper part and light olive brown and calcareous in the lower part. The next layer is light olive brown, calcareous loam about 14 inches thick. The substratum to a depth of about 60 inches is also light olive brown, calcareous loam.

The Maddock soils are on flats and rises and in swales. Typically, the surface soil is black loamy fine sand and sandy loam about 12 inches thick. The substratum to a depth of about 60 inches is fine sand. It is dark yellowish brown in the upper part and light olive brown in the lower part.

Arveson, Arvilla, Buse, Hamerly, Hecla, Southam, Svea, Swenoda, Towner, Ulen, and Wyndmere soils are the principal minor soils in this association. The poorly drained Arveson soils are on low flats. They have an accumulation of lime within a depth of 16 inches. The somewhat excessively drained Arvilla soils are on flats and ridges. They have a surface layer of sandy loam and a subsoil of coarse sandy loam. The well drained Buse soils are on knolls. They are calcareous throughout. The somewhat poorly drained Hamerly, Ulen, and Wyndmere soils are on low flats. They have an accumulation of lime within a depth of 16 inches. The moderately well drained Hecla soils are in swales. They have a mottled substratum. The very poorly drained Southam soils are in depressions. They are calcareous throughout. The moderately well drained Svea soils are in swales. The dark color of the surface layer in these soils extends to a depth of more than 16 inches. The moderately well drained Swenoda and Towner soils are in swales. Swenoda soils have a surface layer and subsoil of fine sandy loam. Towner soils have a subsoil of loamy sand.

In most areas this association is used for cultivated crops or for hay and pasture. In a few areas it is used for range. It is suited to cultivated crops. The rolling Maddock soils are better suited to pasture and range because of the susceptibility to soil blowing and water erosion. The main concern in managing cultivated areas is controlling water erosion and soil blowing.

11. Swenoda-Wyndmere-Hecla Association

Very deep, level to undulating, moderately well drained and somewhat poorly drained, moderately coarse textured soils

This association consists of soils on flats and rises and in swales on lake plains and mantled lake plains. In most areas surface water flows into depressions or percolates into the ground water. Slope ranges from 0 to 6 percent.

This association makes up about 4 percent of the county. It is about 30 percent Swenoda soils, 25 percent Wyndmere soils, 20 percent Hecla soils, and 25 percent soils of minor extent.

The level to undulating, moderately well drained Swenoda soils are on flats and rises. Typically, the surface soil is black fine sandy loam about 11 inches thick. The subsoil is fine sandy loam about 21 inches thick. It is very dark grayish brown in the upper part and grayish brown and calcareous in the lower part. The substratum to a depth of about 60 inches is light olive brown, mottled, and calcareous. It is loamy fine sand in the upper part and silty clay loam in the lower part.

The level and nearly level, somewhat poorly drained Wyndmere soils are on flats and in swales. Typically, the surface soil is calcareous fine sandy loam about 11 inches thick. It is black in the upper part and very dark brown in the lower part. The subsoil is calcareous fine sandy loam about 18 inches thick. It is very dark grayish brown in the upper part, dark grayish brown in the next part, and light brownish gray in the lower part. The substratum to a depth of about 60 inches is light olive brown, mottled, and calcareous. It is loamy fine sand in the upper part, fine sand in the next part, and clay loam in the lower part.

The level and nearly level, moderately well drained Hecla soils are on flats and in swales. Typically, the surface soil is about 23 inches thick. It is black fine sandy loam in the upper part and very dark brown loamy fine sand in the lower part. The next layer is very dark grayish brown, mottled loamy fine sand about 15 inches thick. The substratum to a depth of about 60 inches is mottled and calcareous. It is olive loamy fine sand in the upper part and olive gray clay loam in the lower part.

Arveson, Barnes, Colvin, Embden, Fram, Glyndon,

Kratka, and Towner soils are the principal minor soils in this association. The poorly drained Arveson and Colvin soils are on flats. They have an accumulation of lime within a depth of 16 inches. The well drained Barnes soils are on rises. They are loam throughout the profile. The moderately well drained Embden soils are in swales. They have a subsoil of fine sandy loam and a substratum of fine sand. The somewhat poorly drained Fram and Glyndon soils are on flats and rises. They have an accumulation of lime within a depth of 16 inches. Fram soils are loam. Glyndon soils are mostly silt loam throughout the profile. The poorly drained Kratka soils are in depressions. They are fine sand and loamy fine sand in the upper part of the subsoil and silty clay loam in the substratum. The moderately well drained Towner soils are in swales. They have a subsoil of loamy sand and a substratum of loam.

In most areas this association is used for cultivated crops or for pasture and hay. It is suited to cultivated crops. The main concern in managing cultivated areas is controlling soil blowing. The main concern in managing range or pasture is maintaining an adequate cover of the important or suitable forage plants.

12. Maddock-Lohnes Association

Very deep, level to undulating, well drained, coarse textured soils

This association consists of soils on flats and rises on outwash plains. Surface water flows into drainageways or percolates into the ground water. Slope ranges from 0 to 6 percent.

This association makes up about 1 percent of the county. It is about 40 percent Maddock soils, 35 percent Lohnes soils, and 25 percent soils of minor extent.

The Maddock soils are on flats and rises. Typically, the surface soil is black loamy fine sand about 12 inches thick. The substratum to a depth of about 60 inches is fine sand. It is dark yellowish brown in the upper part and light olive brown in the lower part.

The Lohnes soils are on flats and rises. Typically, the surface soil is black loamy coarse sand about 11 inches thick. The next layer is very dark brown loamy coarse sand about 9 inches thick. The substratum to a depth of about 60 inches is coarse sand. It is dark yellowish brown in the upper part and dark brown, mottled, and calcareous in the lower part.

Arveson, Arvilla, Hecla, and Ulen soils are the principal minor soils in this association. The poorly drained Arveson soils are in swales. They have a surface layer of loam and a subsoil of sandy clay loam and sandy loam. The somewhat excessively drained Arvilla soils are on flats and rises. They have a surface layer of sandy loam and a subsoil of coarse sandy loam. The moderately well drained Hecla soils are in swales. They have a mottled substratum. The somewhat poorly drained Ulen soils are on flats. They have an accumulation of lime within a depth of 16 inches.

In most areas this association is used for pasture and hay. In a few areas it is used for cultivated crops or range. The main concerns in managing cultivated areas are controlling soil blowing and overcoming droughtiness. The main concern in managing range and pasture is maintaining an adequate cover of the native or suitable forage plants.

13. Arvilla-Sioux-Colvin Association

Very deep, level to moderately sloping, somewhat excessively drained, excessively drained, and poorly drained, moderately coarse textured and medium textured soils

This association consists of soils on flats, ridges, and rises on outwash plains and flood plains. Slope ranges from 0 to 9 percent.

This association makes up about 4 percent of the county. It is about 30 percent Arvilla soils, 20 percent Sioux soils, 20 percent Colvin soils, and 30 percent soils of minor extent.

The level to moderately sloping, somewhat excessively drained Arvilla soils are on flats and rises. Typically, the surface soil is black sandy loam about 11 inches thick. The subsoil is dark brown coarse sandy loam about 7 inches thick. The substratum extends to a depth of about 60 inches. It is dark yellowish brown gravelly coarse sand in the upper part, dark brown coarse sand in the next part, and brown sand in the lower part. It is calcareous.

The nearly level to moderately sloping, excessively drained Sioux soils are on flats and ridges. Typically, the surface layer is black loam about 7 inches thick. The next layer is dark brown, calcareous gravelly loamy sand about 6 inches thick. The substratum to a depth of about 60 inches is dark yellowish brown, calcareous very gravelly sand.

The level, poorly drained Colvin soils are on flats on flood plains. Typically, the surface layer is black, calcareous silt loam about 7 inches thick. The subsoil is calcareous. It is about 29 inches thick. It is dark gray silty clay loam in the upper part, grayish brown silty clay loam in the next part, and light gray and olive, mottled silt loam in the lower part. The substratum to a depth of about 60 inches is gray, mottled silt loam.

Barnes, Coe, Divide, La Prairie, and Maddock soils are the principal minor soils in this association. The well drained Barnes soils are on rises. They are loam throughout the profile. The excessively drained Coe

soils are on the steep valley side slopes. They have a shaly, gravelly substratum. The somewhat poorly drained Divide soils are on flats. They have an accumulation of lime within a depth of 16 inches. The moderately well drained La Prairie soils are on flood plains and terraces. They are loam throughout the profile. The well drained Maddock soils are on ridges. They have a surface layer of loamy fine sand and a substratum of fine sand.

In most areas this association is used for cultivated crops, range, or hay. It is poorly suited to cultivated crops. The main concerns in managing cultivated areas are controlling soil blowing and overcoming droughtiness. Flooding is a major concern on the Colvin soils. The main concern in managing range or pasture is maintaining an adequate cover of the important or suitable forage plants.

14. Divide-Fram Association

Very deep, level and nearly level, somewhat poorly drained, medium textured soils

This association consists of soils on flats and rises. Surface water flows into depressions and drainageways. Slope ranges from 0 to 3 percent.

This association makes up about 2 percent of the county. It is about 35 percent Divide soils, 30 percent Fram soils, and 35 percent soils of minor extent.

The Divide soils typically have a surface soil of black loam about 10 inches thick. The subsoil is calcareous loam about 16 inches thick. It is gray in the upper part and light olive brown and mottled in the lower part. The next layer is light olive brown, mottled, calcareous sandy loam about 4 inches thick. The substratum to a depth of about 60 inches is light olive brown and light brownish gray, mottled sand.

The Fram soils typically have a surface layer of black, calcareous loam about 8 inches thick. The subsoil is calcareous loam about 15 inches thick. It is light brownish gray and mottled in the upper part and light olive brown and grayish brown in the lower part. The substratum to a depth of about 60 inches is olive brown, mottled, calcareous loam.

Arveson, Arvilla, Emrick, Heimdal, Parnell, and Vallers soils are the principal minor soils in this association. The poorly drained Arveson soils are in swales. They have a subsoil that is sandy clay loam in the upper part. The somewhat excessively drained Arvilla soils are on rises. They have a surface layer of sandy loam and a subsoil of coarse sandy loam. The moderately well drained Emrick soils are in swales, and the well drained Heimdal soils are on rises. Both of these soils do not have an accumulation of lime within a depth of 16 inches. The very poorly drained Parnell soils are in depressions. They have an accumulation of clay in the subsoil. The poorly drained Vallers soils are on flats.

In most areas this association is used for cultivated crops. In some areas it is used for grass-legume hay. It is well suited to these uses. The main concern in managing cultivated areas is controlling soil blowing. The main concern in managing hayland is maintaining an adequate cover of the important or suitable forage plants.

Detailed Soil Map Units

The map units on the detailed soil maps at the back of this survey represent the soils in the survey area. The map unit descriptions in this section, along with the soil maps, can be used to determine the suitability and potential of a soil for specific uses. They also can be used to plan the management needed for those uses. More information on each map unit, or soil, is given under the heading "Use and Management of the Soils."

Each map unit on the detailed soil maps represents an area on the landscape and consists of one or more soils for which the unit is named.

A symbol identifying the soil precedes the map unit name in the soil descriptions. Each description includes general facts about the soil and gives the principal hazards and limitations to be considered in planning for specific uses.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer or of the substratum, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer or of the substratum. They also can differ in slope, stoniness, salinity, wetness, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Colvin silt loam, wet, is a phase of the Colvin series.

Some map units are made up of two or more major soils. These map units are called soil complexes or undifferentiated groups.

A *soil complex* consists of two or more soils, or one or more soils and a miscellaneous area, in such an intricate pattern or in such small areas that they cannot be shown separately on the soil maps. The pattern and proportion of the soils are somewhat similar in all areas. Maddock-Barnes-Towner complex, 6 to 15 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils in the mapped areas are not uniform. An area can be made up of only one of the major soils, or it can be made up of all of them. Vallers and Hamerly loams, saline, is an undifferentiated group in this survey area.

Most map units include small scattered areas of soils other than those for which the map unit is named. Some of these included soils have properties that differ substantially from those of the major soil or soils. Such differences could significantly affect use and management of the soils in the map unit. The included soils are identified in each map unit description. Some small areas of strongly contrasting soils are identified by a special symbol on the soil maps.

This survey includes *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. The map unit Pits, sand and gravel, is an example. Miscellaneous areas are shown on the soil maps. Most are identified by a special symbol on the soil maps.

As a result of changes in series concepts, the location of moisture regime areas, differing soil patterns, and differences in the design of the map units, some of the soil boundaries and soil names on the detailed soil map of this county do not match those on the maps of Eddy, Griggs, Stutsman, and Wells Counties, North Dakota.

Table 4 gives the acreage and proportionate extent of each map unit. Other tables (see "Summary of Tables") give properties of the soils and the limitations, capabilities, and potentials for many uses. The "Glossary" defines many of the terms used in describing the soils.

Soil Descriptions

1—Southam silt loam. This very deep, level, very poorly drained, calcareous soil is in depressions on till plains and lake plains. It is ponded. Individual areas range from about 3 to 450 acres in size.

Typically, the surface soil is black and calcareous. It is about 32 inches thick. It is silt loam in the upper part

Figure 6.—Habitat for wetland wildlife in an area of Southam silt loam. The dominant vegetation is cattails.

and silty clay loam in the lower part. The substratum to a depth of about 60 inches is black, calcareous silty clay. In some areas the soil has less clay throughout the profile. In other areas, the soil is ponded for shorter periods and a layer of accumulated clay is at a depth of 20 to 30 inches.

Included with this soil in mapping are small areas of the poorly drained Vallers soils. These soils make up about 5 percent of the unit. They are on flats surrounding depressions.

Permeability is slow in the Southam soil, and runoff is ponded. Available water capacity is high. The seasonal high water table is 5 feet above to 1 foot below the surface. Organic matter content is very high.

Most areas are used for wetland wildlife habitat (fig. 6). This soil is best suited to this use. Because of the ponding and the lack of suitable drainage outlets, it generally is unsuited to cultivated crops, pasture, hay, and range and to the trees and shrubs grown as windbreaks and environmental plantings.

Areas of this soil and the ponded water provide excellent winter cover for resident wildlife and high-quality feeding, breeding, and rearing sites for wetland wildlife. The main concerns in managing wetland wildlife habitat are maintaining the natural wetness and preventing siltation.

The land capability classification is VIIIw. The productivity index for spring wheat is 0. A range site or pasture group is not assigned.

2—Parnell silty clay loam. This very deep, level, very poorly drained soil is in depressions on till plains. It is ponded. Individual areas range from about 3 to 100 acres in size.

Typically, the surface layer is black silty clay loam about 9 inches thick. The subsoil is clay loam about 35 inches thick. It is dark olive gray in the upper part and olive gray and mottled in the lower part. The substratum

to a depth of about 60 inches is olive gray, mottled clay loam. In some areas the subsurface layer is light in color. In other areas the subsoil does not have an accumulation of clay. In some places the surface layer is silt loam.

Included with this soil in mapping are small areas of the poorly drained Vallers soils. These soils make up about 10 percent of the unit. They are on flats surrounding depressions.

Permeability is slow in the Parnell soil, and runoff is ponded. Available water capacity is high. The seasonal high water table is 2 feet above to 2 feet below the surface. Organic matter content is high. Tilth is good.

Most areas are used for wetland wildlife habitat, hay, or range. A few areas are drained and cultivated. If drained, this soil is suited to cultivated crops and to grasses and legumes for hay and pasture. It is best suited to wetland wildlife habitat, hay, and range. The hazards of soil blowing and water erosion are slight. The excessive wetness is a critical limitation affecting crops and pasture. A drainage system increases the suitability of the soil for cultivated crops; however, locating suitable drainage outlets is difficult. In undrained areas crops are planted and harvested in only about 2 years out of 10. In areas where the soil is drained and cultivated, a system of conservation tillage that leaves crop residue on the surface helps to control erosion. Conservation tillage also provides food and cover for resident and migratory wildlife.

Areas of this soil and the ponded water provide excellent winter cover for resident wildlife and high-quality feeding, breeding, and rearing sites for wetland wildlife. The main concerns in managing wetland wildlife habitat are maintaining the natural wetness and preventing siltation.

In areas where this soil is used as range, the important native forage plants are rivergrass and slough sedge. If this soil is drained, reed canarygrass, creeping foxtail, and alsike clover are suitable hay and pasture plants. Compaction, trampling, and root shearing are problems, especially if the range or pasture is grazed when the soil is wet. Grazing should be deferred during wet periods.

If drained, this soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Undrained areas generally are unsuited to the climatically adapted species. The wetness is a critical limitation affecting survival, growth, and vigor. The grasses and weeds growing on this soil are abundant and persistent. Eliminating this ground cover before the trees and shrubs are planted and then controlling the regrowth of this cover improve the survival and growth rates of the seedlings.

The land capability classification is IIIw. The productivity index for spring wheat is 20 to 68, depending on the degree of drainage. The range site is Wetland. In drained areas the pasture group is Wet.

3—Tonka silt loam. This very deep, level, poorly drained soil is in depressions on till plains. It is ponded. Individual areas range from about 3 to 100 acres in size.

Typically, the surface layer is black silt loam about 9 inches thick. The subsurface layer is dark gray, mottled silt loam about 6 inches thick. The subsoil is about 35 inches thick. It is very dark grayish brown silty clay in the upper part; olive gray, mottled clay in the next part; and light brownish gray, mottled, calcareous loam in the lower part. The substratum to a depth of about 60 inches is olive brown, mottled, calcareous loam. In some areas the soil does not have a subsurface layer. In other areas the subsoil does not have an accumulation of clay.

Included with this soil in mapping are small areas of the somewhat poorly drained Hamerly soils. These soils make up about 10 percent of the unit. They are on flats surrounding depressions.

Permeability is slow in the Tonka soil, and runoff is ponded. Available water capacity is high. The seasonal high water table is 0.5 foot above to 1.0 foot below the surface. Organic matter content is high. Tilth is good.

Most areas are used for cultivated crops, hay, range, or wetland wildlife habitat. This soil is suited to cultivated crops and to grasses and legumes for hay and pasture. The hazards of soil blowing and water erosion are slight. The excessive wetness is a critical limitation affecting crop production. A drainage system increases the suitability of the soil for cultivated crops; however, locating suitable drainage outlets is difficult. In undrained areas cultivated crops are harvested in only about 5 years out of 10. In areas where the soil is drained and cultivated, a system of conservation tillage that leaves crop residue on the surface helps to control erosion. Conservation tillage also provides food and cover for resident and migratory wildlife.

Areas of this soil and the ponded water provide an early season breeding site and a good source of invertebrate protein for wetland wildlife. The main concerns in managing wetland wildlife habitat are maintaining the natural wetness and preventing siltation.

In areas where this soil is used for range, the important native forage plants are slim sedge and wooly sedge. Alsike clover, reed canarygrass, and creeping foxtail are suitable hay and pasture plants. Compaction, trampling, and root shearing are problems, especially if the range or pasture is grazed when the soil is wet. Grazing should be deferred during wet periods.

If drained, this soil is suited to all of the climatically

adapted trees and shrubs grown as windbreaks and environmental plantings. Undrained areas generally are unsuited to the climatically adapted species. The wetness is a critical limitation affecting survival, growth, and vigor. The grasses and weeds growing on this soil are abundant and persistent. Eliminating this ground cover before the trees and shrubs are planted and then controlling the regrowth of this cover improve the survival and growth rates of the seedlings.

The land capability classification is IIw. The productivity index for spring wheat is 42 to 84, depending on the degree of drainage. The range site is Wet Meadow. The pasture group is Wet.

4—Manfred loam. This very deep, level, poorly drained, sodic, saline soil is in depressions on till plains. It is ponded. Individual areas range from about 3 to 100 acres in size.

Typically, the surface layer is black loam about 7 inches thick. The subsoil is about 39 inches thick. In sequence downward, it is dark olive gray clay loam; olive gray, mottled loam; olive gray, mottled, calcareous loam; and light olive brown, mottled, calcareous silt loam. The substratum to a depth of about 60 inches is dark grayish brown, mottled, calcareous loam. In some areas the soil has more clay in the subsoil and substratum. In other areas it has less clay. In some places, the surface layer is only 3 to 5 inches thick and salts are within a depth of 16 inches. In other places the soil has an accumulation of lime within a depth of 16 inches.

Included with this soil in mapping are small areas of Cathay, Fram, Larson, and Parnell soils. These soils make up about 20 percent of the unit. The Cathay, Fram, and Larson soils are on rises. The Cathay soils are moderately well drained. The Fram and Larson soils are somewhat poorly drained. The very poorly drained Parnell soils are in depressions.

Permeability is slow in the Manfred soil, and runoff is ponded. Available water capacity is moderate. The content of salt in the soil reduces the amount of water available to plants. The dense, sodic subsoil restricts the rooting depth of plants. The seasonal high water table is 1 foot above to 1 foot below the surface. Organic matter content is high.

Most areas are used for hay, range, or wetland wildlife habitat. A few areas are drained and cultivated. This soil is generally unsuited to cultivated crops and to the trees and shrubs grown as windbreaks and environmental plantings because of the wetness, the salinity, and the restricted rooting depth. It is best suited to hay, range, and wetland wildlife habitat.

Areas of this soil and the ponded water provide excellent winter cover for resident wildlife and high-quality feeding, breeding, and rearing sites for wetland wildlife. The main concerns in managing wetland wildlife habitat are maintaining the natural wetness and preventing siltation.

In areas where this soil is used as range, the important native forage plants are alkali cordgrass, western wheatgrass, Nuttall alkaligrass, and inland saltgrass. Tall wheatgrass, slender wheatgrass, sweetclover, and alsike clover are suitable hay and pasture plants. Compaction, trampling, and root shearing are problems, especially if the range or pasture is grazed when the soil is wet. Grazing should be deferred during wet periods. Stock water ponds constructed in areas of this soil frequently contain salty water.

The land capability classification is VIs. The productivity index for spring wheat is 0. The range site is Saline Lowland. The pasture group is Sodic and Saline.

7—Colvin silt loam, wet. This very deep, level, very poorly drained, highly calcareous soil is in depressions on lake plains. It is ponded. Individual areas range from about 5 to 500 acres in size.

Typically, the surface layer is black, calcareous silt loam about 7 inches thick. The subsoil is calcareous. It is about 29 inches thick. It is dark gray silty clay loam in the upper part, grayish brown silty clay loam in the next part, and light gray and olive, mottled silt loam in the lower part. The substratum to a depth of about 60 inches is gray, mottled, calcareous silt loam. In some areas the subsoil and substratum are silty clay. In other areas they are loam. In some places the soil is saline.

Included with this soil in mapping are small areas of Southam soils. These soils make up about 5 percent of the unit. They do not have an accumulation of lime within a depth of 16 inches. They are in the deeper parts of depressions.

Permeability is moderately slow in the Colvin soil, and runoff is ponded. Available water capacity is high. The seasonal high water table is 1 foot above to 1 foot below the surface. Organic matter content is high. Tilth is good.

Most areas are used for wetland wildlife habitat, hay, or range. A few areas are drained and cultivated. The excessive wetness is a critical limitation affecting crops and pasture. A drainage system increases the suitability of the soil for cultivated crops, however, locating suitable drainage outlets is difficult. If drained, this soil is suited to cultivated crops and to grasses and legumes for hay and pasture. It is best suited to hay, range, and wetland wildlife habitat. The hazard of soil blowing is moderate, and the hazard of water erosion is slight. In undrained areas crops are planted and

harvested in only about 2 years out of 10. In areas where the soil is drained and cultivated, a system of conservation tillage that leaves crop residue on the surface and field windbreaks help to control soil blowing. Conservation tillage also provides food and cover for resident and migratory wildlife.

Areas of this soil and the ponded water provide excellent winter cover for resident wildlife and high-quality feeding, breeding, and rearing sites for wetland wildlife. The main concerns in managing wetland wildlife habitat are maintaining the natural wetness and preventing siltation.

In areas where this soil is used as range, the important native forage plants are rivergrass and slough sedge. If this soil is drained, reed canarygrass, big bluestem, and alsike clover are suitable hay and pasture plants. Compaction, trampling, and root shearing are problems, especially if the range or pasture is grazed when the soil is wet. Grazing should be deferred during wet periods.

If drained, this soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Undrained areas generally are unsuited to the climatically adapted species. The wetness is a critical limitation affecting survival, growth, and vigor. The grasses and weeds growing on this soil are abundant and persistent. Eliminating this ground cover before the trees and shrubs are planted and then controlling the regrowth of this cover improve the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification is IIIw. The productivity index for spring wheat is 10 to 54, depending on the degree of drainage. The range site is Wetland. In drained areas the pasture group is Wet.

8—Minnewaukan loamy fine sand. This very deep, level, poorly drained soil is on flats on lake plains. Individual areas range from about 10 to 400 acres in size.

Typically, the surface layer is black, calcareous loamy fine sand about 1 inch thick. The next layer is dark gray, mottled, calcareous fine sand about 8 inches thick. The substratum to a depth of about 60 inches is calcareous. In sequence downward it is gray, mottled fine sand; olive gray, mottled loamy fine sand; gray fine sand; gray, mottled fine sandy loam; and dark gray, mottled fine sand. In some areas the soil is very poorly drained or somewhat poorly drained. In other areas the surface layer is 7 to 10 inches thick. In some places the substratum is loam or clay loam.

Included with this soil in mapping are small areas of the moderately well drained Hecla soils. These soils are on rises that are higher on the landscape than the Minnewaukan soil. Also included are areas of somewhat poorly drained soils that have a silty substratum within a depth of 20 inches. These soils also are on rises. The included soils make up about 10 percent of the unit.

Permeability is rapid in the Minnewaukan soil, and runoff is very slow. Available water capacity is low. The seasonal high water table is within a depth of 2.5 feet. Organic matter content is moderate. Tilth is good.

Most areas are used for range or wildlife habitat. This soil is poorly suited to cultivated crops. The hazard of soil blowing is severe, and the hazard of water erosion is slight. The excessive wetness is a critical limitation affecting crop production. A drainage system increases the suitability of the soil for cultivated crops; however, locating suitable drainage outlets is difficult. In undrained areas cultivated crops are harvested in only about 5 years out of 10. In areas where the soil is drained and cultivated, a system of conservation tillage that leaves crop residue on the surface and field windbreaks help to control soil blowing. Conservation tillage also provides food and cover for resident and migratory wildlife.

In areas where this soil is used as range, the important native forage plants are big bluestem and switchgrass. Alsike clover, reed canarygrass, and creeping foxtail are suitable hay and pasture plants. The soil blowing is a hazard, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable plants helps to control soil blowing.

If drained, this soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Undrained areas generally are unsuited to the climatically adapted species. The wetness is a critical limitation affecting survival, growth, and vigor. The grasses and weeds growing on this soil are abundant and persistent. Eliminating this ground cover before the trees and shrubs are planted and then controlling the regrowth of this cover improve the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification is IVs. The productivity index for spring wheat is 27. The range site is Subirrigated. The pasture group is Wet.

9—Lallie, saline-Minnewaukan complex. These very deep, level, poorly drained soils are on flats on lake plains. The Lallie soil is saline and is ponded. Individual areas of this unit range from about 10 to 200 acres in size. They are about 55 to 80 percent Lallie soil and 15

to 40 percent Minnewaukan soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the surface layer of the Lallie soil is very dark gray and black, calcareous, stratified loam about 5 inches thick. The substratum to a depth of about 60 inches is calcareous. It is dark grayish brown and very dark gray, stratified, mottled silty clay loam in the upper part and light olive gray, mottled silty clay loam in the lower part. In some areas the surface layer is black and is 6 to 8 inches thick. In other areas the soil is somewhat poorly drained or very poorly drained. In some places the surface layer and substratum are silty clay, silt loam, or clay loam. In other places the soil has thin layers of sand throughout.

Typically, the surface layer of the Minnewaukan soil is black, calcareous loamy fine sand about 1 inch thick. The next layer is dark gray, mottled, calcareous fine sand about 8 inches thick. The substratum to a depth of about 60 inches is calcareous. In sequence downward it is gray, mottled fine sand; olive gray, mottled loamy fine sand; gray fine sand; gray, mottled fine sandy loam; and dark gray, mottled fine sand. In some areas the dark surface layer is 7 to 10 inches thick. In other areas the soil is somewhat poorly drained or very poorly drained. In some places thin layers of silt loam or loam are within a depth of 40 inches. In other places the soil is saline.

Included with these soils in mapping are small areas of the somewhat poorly drained Wyndmere soils on rises. Also included are areas of soils that have a dense, sodic subsoil. These included soils are intermingled with areas of the Minnewaukan and Lallie soils. The included soils make up about 10 percent of the unit.

Permeability is slow in the Lallie soil and rapid in the Minnewaukan soil. Runoff is ponded on the Lallie soil and slow on the Minnewaukan soil. Available water capacity is moderate in the Lallie soil and low in the Minnewaukan soil. The content of salt in the Lallie soil reduces the amount of water available to plants. The seasonal high water table is 1 foot above to 1 foot below the surface in the Lallie soil and within a depth of 2.5 feet in the Minnewaukan soil. Organic matter content is moderate in the Lallie soil and moderately low in the Minnewaukan soil.

Most areas are used for range or wildlife habitat. These soils are generally unsuited to cultivated crops because of the wetness, the salinity, and the low natural fertility. They are best suited to wildlife habitat, hay, pasture, and range. The hazard of soil blowing is slight on the Lallie soil and severe on the Minnewaukan soil. The hazard of water erosion is slight on both soils.

In areas where these soils are used as range, the important native forage plants are alkali cordgrass, western wheatgrass, Nuttall alkaligrass, switchgrass, and big bluestem. Tall wheatgrass, western wheatgrass, reed canarygrass, big bluestem, and alsike clover are suitable hay and pasture plants. The high content of salts, compaction, trampling, and root shearing are problems in areas of the Lallie soil if the range or pasture is grazed when the soil is wet. These problems can be overcome by maintaining an adequate cover of the important or suitable plants and by deferring grazing during wet periods. The soil blowing is a hazard on the Minnewaukan soil, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable forage plants helps to control soil blowing.

The Lallie soil is generally unsuited to the climatically adapted trees and shrubs grown as windbreaks and environmental plantings because of the salinity and the wetness. If drained, the Minnewaukan soil is suited to all of the climatically adapted species; however, undrained areas are generally unsuited. The wetness is a critical limitation affecting survival, growth, and vigor. The grasses and weeds growing on the Minnewaukan soil are abundant and persistent. Eliminating this ground cover before the trees and shrubs are planted and then controlling the regrowth of this cover improve the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification of the Lallie soil is VIs, and that of the Minnewaukan soil is IVs. The productivity index of the unit for spring wheat is 0. The range site of the Lallie soil is Saline Lowland, and that of the Minnewaukan soil is Subirrigated. The pasture group of the Lallie soil is Saline, and that of the Minnewaukan soil is Wet.

10—Colvin and Arveson, loamy substratum, soils, saline. These very deep, level, poorly drained, moderately saline, highly calcareous soils are on flats and in drainageways on outwash plains and lake plains. Individual areas range from about 5 to 500 acres in size. Any one area can consist of all Colvin soil, all Arveson soil, or a combination of both soils.

Typically, the surface layer of the Colvin soil is black, calcareous silt loam about 7 inches thick. The subsoil is calcareous. It is about 29 inches thick. It is dark gray silty clay loam in the upper part; grayish brown silty clay loam in the next part; and light gray and olive, mottled silt loam in the lower part. The substratum to a depth of about 60 inches is gray, mottled, calcareous silt loam. In some areas the subsoil and substratum are loam or

silt loam. In other areas the soil is nonsaline or strongly saline.

Typically, the surface soil of the Arveson soil is calcareous loam about 11 inches thick. It is black in the upper part and very dark gray in the lower part. The subsoil is gray and calcareous. It is about 15 inches thick. It is sandy clay loam in the upper part and sandy loam in the lower part. The substratum to a depth of about 60 inches is olive gray, mottled, and calcareous. It is loamy fine sand in the upper part and clay loam in the lower part. In some areas the substratum above a depth of 40 inches is loam. In other areas the soil is somewhat poorly drained. In some places it is nonsaline or only slightly saline.

Included with these soils in mapping are small areas of Embden, Kratka, Letcher, Manfred, and Parnell soils. These included soils make up about 15 percent of the unit. The Embden and Letcher soils are on rises. The Embden soils are moderately well drained. The Letcher soils are somewhat poorly drained. The Kratka and Manfred soils are intermingled with areas of the Colvin and Arveson soils. The Kratka soils have a surface layer of fine sandy loam. The Manfred soils have a sodic subsoil. The very poorly drained Parnell soils are in depressions.

Permeability is moderately slow in the Colvin soil. It is moderately rapid in the upper part of the Arveson soil and moderately slow in the lower part. Runoff is slow on both soils. Available water capacity is moderate. The content of salt in the soils reduces the amount of water available to plants. The seasonal high water table is within a depth of 2 feet. Organic matter content is high. Tilth is good.

Most areas are used for hay, pasture, range, or wildlife habitat. Some areas are used for cultivated crops. These soils are poorly suited to cultivated crops because of the wetness and the salinity. The hazard of soil blowing is moderate, and the hazard of water erosion is slight. The excessive wetness is a critical limitation affecting crop production. A drainage system increases the suitability of the soils for cultivated crops; however, locating suitable drainage outlets is difficult. Drainage and cultivation can increase the salinity. Planting salt-tolerant crops and avoiding summer fallow and deep tillage help to control the accumulation of salts in the surface layer. A system of conservation tillage that leaves crop residue on the surface, field windbreaks, and stripcropping help to control soil blowing. Conservation tillage also provides food and cover for resident and migratory wildlife.

In areas where these soils are used as range, the important native forage plants are alkali cordgrass and western wheatgrass. Tall wheatgrass, slender wheatgrass, sweetclover, and alsike clover are suitable hay and pasture plants. The high content of salt, compaction, trampling, and root shearing are problems, especially if the range or pasture is grazed when the soils are wet. These problems can be overcome by maintaining an adequate cover of the important or suitable plants and by deferring grazing during wet periods. Stock water ponds constructed in areas of these soils frequently contain salty water.

These soils are suited to only a few of the most salt-tolerant climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Individual trees and shrubs vary in height, density, and vigor, which are affected by the reduced amount of available water caused by the salts in the soils. Reducing the evaporation rate at the surface improves seedling survival. When the bare surface of the soil dries, salt-laden water tends to move to the surface. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification of both soils is IIIs. The productivity index of the unit for spring wheat is 24. The range site of both soils is Saline Lowland. The pasture group is Saline.

17—Vallers and Hamerly loams, saline. These very deep, level, moderately saline, highly calcareous soils are on till plains. The poorly drained Vallers soil is on flats and in drainageways. The somewhat poorly drained Hamerly soil is on flats and rises. Individual areas range from about 5 to 500 acres in size. Any one area can consist of all Vallers soil, all Hamerly soil, or a combination of both soils.

Typically, the surface soil of the Vallers soil is black, calcareous loam about 12 inches thick. The subsoil is light olive gray, mottled, calcareous loam about 12 inches thick. The substratum to a depth of about 60 inches is olive gray, mottled, calcareous loam. In some areas the soil is slightly saline or strongly saline. In other areas the subsoil and substratum are silt loam or silty clay loam. In some places the soil does not have an accumulation of lime within a depth of 16 inches.

Typically, the surface layer of the Hamerly soil is black, calcareous loam about 9 inches thick. The subsoil is calcareous loam about 21 inches thick. It is dark grayish brown in the upper part and light olive brown in the lower part. The substratum to a depth of about 60 inches is light olive brown, calcareous loam. It is mottled below a depth of about 55 inches.

Included with these soils in mapping are small areas of Manfred and Parnell soils. These included soils make up about 15 percent of the unit. They are in depressions. The Manfred soils have a sodic subsoil.

Figure 7.—An area of Vallers and Hamerly loams, saline, in the foreground. The height of the crop varies because the content of salt in the soil varies. The tall, dark plants are kochia, a weedy plant that grows on saline soils.

The Parnell soils have an accumulation of clay in the subsoil.

Permeability is moderately slow in the Vallers and Hamerly soils. Runoff is slow. Available water capacity is moderate. The content of salt in the soil reduces the amount of water available to plants. The seasonal high water table is within a depth of 1 foot in the Vallers soil and at a depth of 2 to 4 feet in the Hamerly soil. Organic matter content is high in both soils. Tilth is good.

Most areas are used for cultivated crops. A few areas are used for hay, pasture, range, or wildlife habitat. These soils are poorly suited to cultivated crops because of the wetness and the salinity (fig. 7). The hazard of soil blowing is moderate, and the hazard of water erosion is slight. The excessive wetness is a critical limitation affecting crop production. A drainage system increases the suitability of the soils for cultivated crops; however, locating suitable drainage outlets is difficult. Drainage and cultivation can increase the salinity. Planting salt-tolerant crops and avoiding summer fallow and deep tillage help to control the accumulation of salts in the surface layer. A system of conservation tillage that leaves crop residue on the surface, field windbreaks, and stripcropping help to control soil blowing. Conservation tillage also provides

food and cover for resident and migratory wildlife.

In areas where these soils are used for range, the important native forage plants are alkali cordgrass, inland saltgrass, and western wheatgrass. Tall wheatgrass, slender wheatgrass, sweetclover, and alsike clover are suitable hay and pasture plants. The high content of salts, compaction, trampling, and root shearing are problems, especially if the range or pasture is grazed when the soils are wet. Grazing should be deferred during wet periods. The soil blowing is a hazard. Maintaining an adequate cover of the important or suitable plants helps to control soil blowing. Stock water ponds constructed in areas of these soils frequently contain salty water.

These soils are suited to only a few of the most salt-tolerant climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Individual trees and shrubs vary in height, density, and vigor, which are affected by the reduced amount of available water caused by the salts in the soils. Reducing the evaporation rate at the surface improves seedling survival. When the bare surface of the soil dries, salt-laden water tends to move to the surface. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification of both soils is IIIs. The productivity index of the unit for spring wheat is 31. The range site of both soils is Saline Lowland. The pasture group is Saline.

21—Svea loam, 0 to 2 percent slopes. This very deep, level and nearly level, moderately well drained soil is on flats on till plains. Individual areas range from about 5 to 1,000 acres in size.

Typically, the surface soil is black loam about 20 inches thick. The subsoil is loam about 12 inches thick. It is very dark grayish brown in the upper part and light yellowish brown and calcareous in the lower part. The substratum to a depth of about 60 inches is olive brown, mottled, calcareous loam. A stone line is commonly in the subsoil. In some areas the dark color of the surface soil extends to a depth of only 8 to 16 inches.

Included with this soil in mapping are small areas of Parnell, Spottswood, Swenoda, Towner, and Wyndmere soils. These soils make up about 10 percent of the unit. The very poorly drained Parnell soils are in depressions. The Spottswood, Swenoda, and Towner soils are intermingled with areas of the Svea soil. The Spottswood soils have sand and gravel at a depth of 20 to 40 inches. The Swenoda soils have a surface layer of fine sandy loam. The Towner soils have a surface layer of sandy loam. The somewhat poorly drained Wyndmere soils are in swales. Also included are some stony areas.

Permeability is moderately slow in the Svea soil, and runoff is slow. Available water capacity is high. The seasonal high water table is at a depth of 4 to 6 feet. Organic matter content is high. Tilth is good.

Most areas are used for cultivated crops or range. This soil is suited to cultivated crops and to grasses and legumes for hay and pasture. The hazards of soil blowing and water erosion are slight. The main management concerns in cultivated areas are controlling erosion and maintaining tilth. A system of conservation tillage that leaves crop residue on the surface helps to control erosion and maintain tilth. Conservation tillage also provides food and cover for resident and migratory wildlife.

In areas where this soil is used for range, the important native forage plants are big bluestem, green needlegrass, and western wheatgrass. Smooth bromegrass, intermediate wheatgrass, alfalfa, and sweetclover are suitable hay and pasture plants. No major hazards affect the use of this soil as range or pasture.

This soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. It has no critical limitations. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings.

The land capability classification is IIc. The productivity index for spring wheat is 92. The range site is Overflow. The pasture group is Overflow and Run-on.

22—Svea-Barnes loams, 0 to 3 percent slopes. These very deep, level and nearly level soils are on till plains. The moderately well drained Svea soil is in swales. The well drained Barnes soil is on rises. Individual areas range from about 5 to 500 acres in size. They are about 50 to 65 percent Svea soil and 30 to 45 percent Barnes soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the surface soil of the Svea soil is black loam about 20 inches thick. The subsoil is loam about 12 inches thick. It is very dark grayish brown in the upper part and light yellowish brown and calcareous in the lower part. The substratum to a depth of about 60 inches is olive brown, mottled, calcareous loam. In some areas the soil has an accumulation of lime within a depth of 16 inches. In other areas the subsoil and substratum are silt loam.

Typically, the surface layer of the Barnes soil is black loam about 9 inches thick. The subsoil is loam about 20

inches thick. It is brown in the upper part and light olive brown and calcareous in the lower part. The next layer is light olive brown, calcareous loam about 14 inches thick. The substratum to a depth of about 60 inches also is light olive brown, calcareous loam. In some areas the subsoil is calcareous throughout.

Included with these soils in mapping are small areas of Parnell, Tonka, and Towner soils. These included soils make up about 5 percent of the unit. The Parnell and Tonka soils are in depressions. The Parnell soils are very poorly drained. The Tonka soils are poorly drained. The Towner soils have a surface layer of sandy loam. They are intermingled with areas of the Svea soil.

Permeability is moderately slow in the Svea and Barnes soils. Runoff is slow. Available water capacity is high. The seasonal high water table is at a depth of 4 to 6 feet in the Svea soil. Organic matter content is high in both soils. Tilth is good.

Most areas are used for cultivated crops. These soils are well suited to cultivated crops and range and to grasses and legumes for hay and pasture. The hazards of soil blowing and water erosion are slight. The main management concerns in cultivated areas are controlling erosion and maintaining tilth. A system of conservation tillage that leaves crop residue on the surface helps to control erosion and maintain tilth. Conservation tillage also provides food and cover for resident and migratory wildlife.

In areas where these soils are used for range, the important native forage plants are big bluestem, green needlegrass, and needleandthread. Smooth bromegrass, intermediate wheatgrass, alfalfa, and sweetclover are suitable hay and pasture plants. No major hazards affect the use of these soils for range and pasture.

The Svea soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Barnes soil is suited to nearly all of the climatically adapted species. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings.

The land capability classification of both soils is IIc. The productivity index of the unit for spring wheat is 90. The range site of the Svea soil is Overflow, and that of the Barnes soil is Silty. The pasture group of the Svea soil is Overflow and Run-on, and that of the Barnes soil is Loamy and Silty.

23—Hamerly-Wyard loams, 0 to 3 percent slopes. These very deep, somewhat poorly drained soils are on till plains. The level and nearly level, highly calcareous Hamerly soil is on rises. The level Wyard soil is in swales. Individual areas range from about 5 to 1,000 acres in size. They are about 60 to 75 percent Hamerly soil and 20 to 30 percent Wyard soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the surface layer of the Hamerly soil is black, calcareous loam about 9 inches thick. The subsoil is calcareous loam about 21 inches thick. It is dark grayish brown in the upper part and light olive brown in the lower part. The substratum to a depth of about 60 inches is light olive brown, calcareous loam. It is mottled below a depth of about 55 inches. In some areas the soil is poorly drained. In other areas it is moderately saline.

Typically, the surface layer of the Wyard soil is black loam about 8 inches thick. The subsoil is loam about 22 inches thick. It is very dark brown and mottled in the upper part, dark grayish brown in the next part, and grayish brown and calcareous in the lower part. The substratum to a depth of about 60 inches is olive brown, mottled, calcareous loam. In some areas the subsoil is not mottled.

Included with these soils in mapping are small areas of Barnes, Buse, Parnell, and Tonka soils. These included soils make up about 10 percent of the unit. The Barnes and Buse soils are well drained. The Barnes soils are on rises. The Buse soils are on knobs. The Parnell and Tonka soils are in depressions. The Parnell soils are very poorly drained. The Tonka soils are poorly drained.

Permeability is moderately slow in the Hamerly soil and moderate in the Wyard soil. Runoff is slow on both soils. Available water capacity is high. The seasonal high water table is at a depth of 2 to 4 feet in the Hamerly soil and at a depth of 1 to 3 feet in the Wyard soil. Organic matter content is high in both soils. Tilth is good.

Most areas are used for cultivated crops. These soils are suited to cultivated crops and range and to grasses and legumes for hay and pasture. The hazard of soil blowing is moderate on the Hamerly soil and slight on the Wyard soil. The hazard of water erosion is slight on both soils. The main management concerns in cultivated areas are controlling soil blowing on the Hamerly soil and overcoming the early season wetness of the Wyard soil. A system of conservation tillage that leaves crop residue on the surface, field windbreaks, and stripcropping help to control soil blowing. Delaying tillage and planting helps to overcome the early season wetness. Conservation tillage also provides food and cover for resident and migratory wildlife.

In areas where these soils are used for range, the important native forage plants are little bluestem, big

bluestem, and green needlegrass. Smooth bromegrass, tall wheatgrass, intermediate wheatgrass, sweetclover, and alfalfa are suitable hay and pasture plants. The soil blowing in areas of the Hamerly soil is a hazard, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable plants helps to control soil blowing.

These soils are suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs in areas of the Hamerly soil help to control soil blowing and protect the seedlings from abrasion.

The land capability classification of the Hamerly soil is IIe, and that of the Wyard soil is IIw. The productivity index of the unit for spring wheat is 82. The range site of the Hamerly soil is Limy Subirrigated, and that of the Wyard soil is Overflow. The pasture group of the Hamerly soil is Limy Subirrigated, and that of the Wyard soil is Overflow and Run-on.

24—Hamerly-Parnell complex, 0 to 3 percent slopes. These very deep soils are on till plains. The level and nearly level, somewhat poorly drained, highly calcareous Hamerly soil is on flats and rises. The level, very poorly drained Parnell soil is in depressions. It is ponded. Individual areas of this unit range from about 5 to 200 acres in size. They are about 60 to 80 percent Hamerly soil and 15 to 30 percent Parnell soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the surface layer of the Hamerly soil is black, calcareous loam about 9 inches thick. The subsoil is calcareous loam about 21 inches thick. It is dark grayish brown in the upper part and light olive brown in the lower part. The substratum to a depth of about 60 inches is light olive brown, calcareous loam. It is mottled below a depth of about 55 inches. In some areas the soil is poorly drained.

Typically, the surface layer of the Parnell soil is black silty clay loam about 9 inches thick. The subsoil is clay loam about 35 inches thick. It is dark olive gray in the upper part and olive gray and mottled in the lower part. The substratum to a depth of about 60 inches is olive gray, mottled clay loam. In some areas the soil has a subsurface layer that is light in color.

Included with these soils in mapping are small areas of the poorly drained, saline Vallers soils. These included soils make up about 10 percent of the unit. They are on flats surrounding depressions.

Permeability is moderately slow in the Hamerly soil and slow in the Parnell soil. Runoff is slow on the Hamerly soil and ponded on the Parnell soil. Available water capacity is high in both soils. The seasonal high water table is at a depth of 2 to 4 feet in the Hamerly soil and 2 feet above to 2 feet below the surface in the Parnell soil. Organic matter content is high in both soils. Tilth is good.

Most areas are used for cultivated crops, range, hay, or wetland wildlife habitat. The Hamerly soil and drained areas of the Parnell soil are suited to cultivated crops and to grasses and legumes for hay and pasture. The hazard of soil blowing is moderate on the Hamerly soil and slight on the Parnell soil. The hazard of water erosion is slight on both soils. The main management concerns in cultivated areas are soil blowing on the Hamerly soil and the wetness of the Parnell soil. A drainage system on the Parnell soil increases the suitability for cultivated crops; however, locating suitable drainage outlets is difficult. In undrained areas crops are planted and harvested in only about 2 years out of 10. A system of conservation tillage that leaves crop residue on the surface, field windbreaks, and stripcropping help to control soil blowing. Conservation tillage also provides food and cover for resident and migratory wildlife.

Areas of the Parnell soil and the ponded water provide excellent winter cover for resident wildlife and high-quality feeding, breeding, and rearing sites for wetland wildlife. The main concerns in managing wetland wildlife habitat are maintaining the natural wetness and preventing siltation.

In areas where these soils are used for range, the important native forage plants are little bluestem, big bluestem, switchgrass, rivergrass, prairie cordgrass, and slough sedge. Smooth bromegrass, tall wheatgrass, intermediate wheatgrass, sweetclover, and alfalfa are suitable hay and pasture plants on the Hamerly soil. Compaction, trampling, and root shearing are problems, especially if the range or pasture is grazed when the soil is wet. Grazing should be deferred during wet periods. The soil blowing is a hazard, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable plants helps to control soil blowing.

The Hamerly soil and drained areas of the Parnell soil are suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Undrained areas of the Parnell soil are unsuited to the climatically adapted species. The wetness and the ponding are critical limitations affecting survival, growth, and vigor. The grasses and weeds growing on these soils are abundant and persistent. Eliminating this ground cover before the trees and shrubs are planted and then controlling the regrowth of

this cover improve the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs in areas of the Hamerly soil help to control soil blowing and protect the seedlings from abrasion.

The land capability classification of the Hamerly soil is IIe, and that of the Parnell soil is IIIw. The productivity index of the unit for spring wheat is 67 to 79, depending on the degree of drainage in areas of the Parnell soil. The range site of the Hamerly soil is Limy Subirrigated, and that of the Parnell soil is Wetland. The pasture group of the Hamerly soil is Limy Subirrigated, and that in drained areas of the Parnell soil is Wet.

25B—Barnes-Maddock, loamy substratum, complex, 3 to 6 percent slopes. These very deep, undulating, well drained soils are on mantled till plains. The Barnes soil is on rises. The Maddock soil is in swales. Individual areas range from about 5 to 100 acres in size. They are about 40 to 60 percent Barnes soil and 30 to 55 percent Maddock soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the surface layer of the Barnes soil is black loam about 9 inches thick. The subsoil is loam about 20 inches thick. It is brown in the upper part and light olive brown and calcareous in the lower part. The next layer is light olive brown, calcareous loam about 14 inches thick. The substratum to a depth of about 60 inches also is light olive brown, calcareous loam. In some areas the dark color of the surface layer extends to a depth of more than 16 inches. In other areas the subsoil is calcareous throughout.

Typically, the surface layer of the Maddock soil is black sandy loam about 8 inches thick. The subsoil is loamy sand about 33 inches thick. It is very dark brown in the upper part and dark brown in the lower part. The substratum to a depth of about 60 inches is olive brown, mottled clay loam. In some areas the substratum is fine sand. In other areas the soil has a substratum of loam at a depth of 20 to 40 inches. In some places the substratum is mottled.

Included with these soils in mapping are small areas of Kratka, Letcher, and Sioux soils. These included soils make up about 5 percent of the unit. The poorly drained Kratka soils are in depressions. The somewhat poorly drained Letcher soils have a sodic subsoil. They are in swales. The excessively drained Sioux soils have a gravelly substratum. They are on ridges.

Permeability is moderately slow in the Barnes soil. It is rapid in the upper part of the Maddock soil and moderately slow in the lower part. Runoff is medium on the Barnes soil and slow on the Maddock soil. Available water capacity is high in the Barnes soil and moderate in the Maddock soil. Organic matter content is high in the Barnes soil and moderate in the Maddock soil. Tilth of both soils is good.

Most areas are used for cultivated crops. Some areas are used for range, hay, or pasture. These soils are suited to cultivated crops and to grasses and legumes for hay and pasture. The hazard of soil blowing is slight on the Barnes soil and severe on the Maddock soil. The hazard of water erosion is moderate on the Barnes soil and slight on the Maddock soil. The main management concern in cultivated areas is controlling soil blowing and water erosion. A system of conservation tillage that leaves crop residue on the surface, field windbreaks, and stripcropping help to control soil blowing and water erosion. Conservation tillage also provides food and cover for resident and migratory wildlife.

In areas where these soils are used for range, the important native forage plants are western wheatgrass, green needlegrass, prairie sandreed, and needleandthread. Intermediate wheatgrass, slender wheatgrass, alfalfa, and sweetclover are suitable hay and pasture plants. Soil blowing and water erosion are hazards, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable plants helps to control erosion.

The Barnes soil is suited to nearly all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Maddock soil is suited to many of the climatically adapted species. Because the Maddock soil is somewhat droughty, the trees and shrubs commonly are affected by moisture stress, particularly during the establishment period. Irrigation helps to ensure the survival of seedlings. Little benefit is derived from fallowing during the season prior to planting because of the moderate available water capacity. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs in areas of the Maddock soil help to control soil blowing and protect the seedlings from abrasion.

The land capability classification of the Barnes soil is IIe, and that of the Maddock soil is IIIe. The productivity index of the unit for spring wheat is 58. The range site of the Barnes soil is Silty, and that of the Maddock soil is Sandy. The pasture group of the Barnes soil is Loamy and Silty, and that of the Maddock soil is Sandy.

26B—Barnes-Svea loams, 3 to 6 percent slopes. These very deep, undulating soils are on till plains. The well drained Barnes soil is on rises. The moderately

Figure 8.—Small grain, which has been swathed in preparation for combining, in an area of Barnes-Svea loams, 3 to 6 percent slopes. Bales of alfalfa hay are in the background.

well drained Svea soil is in swales. Individual areas range from about 5 to 500 acres in size. They are about 50 to 60 percent Barnes soil and 35 to 50 percent Svea soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the surface layer of the Barnes soil is black loam about 9 inches thick. The subsoil is loam about 20 inches thick. It is brown in the upper part and olive brown and calcareous in the lower part. The next layer is light olive brown, calcareous loam about 14 inches thick. The substratum to a depth of about 60 inches also is light olive brown, calcareous loam. In some areas the subsoil is calcareous throughout.

Typically, the surface soil of the Svea soil is black loam about 20 inches thick. The subsoil is loam about 12 inches thick. It is very dark grayish brown in the upper part and light yellowish brown and calcareous in the lower part. The substratum to a depth of about 60 inches is olive brown, mottled, calcareous loam. In some areas the subsoil and substratum are silt loam. In other areas the subsoil has an accumulation of lime within a depth of 16 inches.

Included with these soils in mapping are small areas of Parnell and Tonka soils. These included soils make up about 5 percent of the unit. They are in depressions. The Parnell soils are very poorly drained. The Tonka soils are poorly drained.

Permeability is moderately slow in the Barnes and Svea soils. Runoff is medium on the Barnes soil and slow on the Svea soil. Available water capacity is high in both soils. The seasonal high water table is at a depth of 4 to 6 feet in the Svea soil. Organic matter content is high in both soils. Tilth is good.

Most areas are used for cultivated crops. These soils are suited to cultivated crops and range and to grasses and legumes for hay and pasture (fig. 8). The hazard of soil blowing is slight, and the hazard of water erosion is moderate. The main management concern in cultivated areas is controlling water erosion. A system of conservation tillage that leaves crop residue on the surface and grassed waterways in areas where runoff concentrates help to control water erosion. Conservation tillage also provides food and cover for resident and migratory wildlife.

In areas where these soils are used for range, the important native forage plants are western wheatgrass,

green needlegrass, and needleandthread. Smooth bromegrass, intermediate wheatgrass, alfalfa, and sweetclover are suitable hay and pasture plants. Water erosion is a hazard, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable plants helps to control water erosion.

The Barnes soil is suited to nearly all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Svea soil is suited to all of the climatically adapted species. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings.

The land capability classification of both soils is IIe. The productivity index of the unit for spring wheat is 80. The range site of both soils is Silty. The pasture group is Loamy and Silty.

27B—Barnes-Buse loams, 3 to 6 percent slopes. These very deep, undulating, well drained soils are on till plains. The Barnes soil is on flats and rises. The Buse soil is on knobs. Individual areas range from about 5 to 800 acres in size. They are about 55 to 65 percent Barnes soil and 25 to 35 percent Buse soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the surface layer of the Barnes soil is black loam about 9 inches thick. The subsoil is loam about 20 inches thick. It is brown in the upper part and light olive brown and calcareous in the lower part. The next layer is light olive brown, calcareous loam about 14 inches thick. The substratum to a depth of about 60 inches also is light olive brown, calcareous loam. In some areas the dark color of the surface layer extends to a depth of more than 16 inches.

Typically, the surface layer of the Buse soil is very dark gray, calcareous loam about 7 inches thick. The subsoil is light olive brown, calcareous loam about 11 inches thick. The substratum to a depth of about 60 inches also is light olive brown, calcareous loam.

Included with these soils in mapping are small areas of Hamerly and Tonka soils. These included soils make up about 10 percent of the unit. The somewhat poorly drained Hamerly soils are on flats. The poorly drained Tonka soils are in depressions.

Permeability is moderately slow in the Barnes and Buse soils. Runoff is medium. Available water capacity is high. Organic matter content is high in the Barnes soil and moderately low in the Buse soil. Tilth of both soils is good.

Most areas are used for cultivated crops. These soils are suited to cultivated crops and range and to grasses and legumes for hay and pasture. The hazard of soil blowing is moderate on the Buse soil and slight on the Barnes soil. The hazard of water erosion is moderate on both soils. The main management concern in cultivated areas is controlling soil blowing and water erosion. A system of conservation tillage that leaves crop residue on the surface, field windbreaks, stripcropping, and grassed waterways in areas where runoff concentrates help to control erosion. Conservation tillage also provides food and cover for resident and migratory wildlife.

In areas where these soils are used for range, the important native forage plants are western wheatgrass, green needlegrass, little bluestem, and needleandthread. Smooth bromegrass, intermediate wheatgrass, alfalfa, and sweetclover are suitable hay and pasture plants. Soil blowing and water erosion are hazards, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable plants helps to control erosion.

The Barnes soil is suited to nearly all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Buse soil is suited to only the most drought-tolerant species. Optimum growth, survival, and vigor are unlikely on the Buse soil. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs in areas of the Buse soil help to control soil blowing and protect the seedlings from abrasion.

The land capability classification of the Barnes soil is IIe, and that of the Buse soil is IIIe. The productivity index of the unit for spring wheat is 69. The range site of the Barnes soil is Silty, and that of the Buse soil is Thin Upland. The pasture group of the Barnes soil is Loamy and Silty, and that of the Buse soil is Thin Upland.

27C—Barnes-Buse loams, 6 to 9 percent slopes. These very deep, gently rolling, well drained soils are on till plains. The Barnes soil is on rises. The Buse soil is on knobs and knolls. Individual areas range from about 5 to 200 acres in size. They are about 55 to 70 percent Barnes soil and 20 to 35 percent Buse soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the surface layer of the Barnes soil is black loam about 9 inches thick. The subsoil is loam about 20 inches thick. It is brown in the upper part and light olive brown and calcareous in the lower part. The next layer is light olive brown, calcareous loam about 14 inches thick. The substratum to a depth of about 60 inches

also is light olive brown, calcareous loam. In some areas the dark color of the surface layer extends to a depth of more than 16 inches.

Typically, the surface layer of the Buse soil is very dark gray, calcareous loam about 7 inches thick. The subsoil is light olive brown, calcareous loam about 11 inches thick. The substratum to a depth of about 60 inches also is light olive brown, calcareous loam. In some eroded areas the surface layer is lighter in color.

Included with these soils in mapping are small areas of Embden, Hamerly, Parnell, and Towner soils. These included soils make up about 10 percent of the unit. The moderately well drained Embden and Towner soils are in swales. The somewhat poorly drained Hamerly soils are on flats. The very poorly drained Parnell soils are in depressions.

Permeability is moderately slow in the Barnes and Buse soils. Runoff is medium on the Barnes soil and rapid on the Buse soil. Available water capacity is high in both soils. Organic matter content is high in the Barnes soil and moderately low in the Buse soil. Tilth of both soils is good.

Most areas are used for cultivated crops. Some areas are used for hay or range. These soils are suited to cultivated crops and to grasses and legumes for hay and pasture. The hazard of soil blowing is moderate on the Buse soil and slight on the Barnes soil. The hazard of water erosion is severe on both soils. The main management concern in cultivated areas is controlling soil blowing and water erosion. A system of conservation tillage that leaves crop residue on the surface, field windbreaks, stripcropping, and grassed waterways in areas where runoff concentrates help to control erosion. Conservation tillage also provides food and cover for resident and migratory wildlife.

In areas where these soils are used for range, the important native forage plants are needleandthread, western wheatgrass, green needlegrass, and little bluestem. Alfalfa, sweetclover, intermediate wheatgrass, and smooth bromegrass are suitable hay and pasture plants. Soil blowing and water erosion are hazards, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable plants helps to control erosion.

The Barnes soil is suited to nearly all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Buse soil is suited to only the most drought-tolerant species. Optimum growth, survival, and vigor are unlikely on the Buse soil. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs in areas of the Buse soil help to control soil blowing and protect the seedlings from abrasion.

The land capability classification of the Barnes soil is IIIe, and that of the Buse soil is IVe. The productivity index of the unit for spring wheat is 58. The range site of the Barnes soil is Silty, and that of the Buse soil is Thin Upland. The pasture group of the Barnes soil is Loamy and Silty, and that of the Buse soil is Thin Upland.

28F—Barnes-Buse loams, 15 to 35 percent slopes. These very deep, well drained soils are on moraines. The hilly Barnes soil is on side slopes. The hilly and steep Buse soil is on knobs and knolls. Individual areas range from about 5 to 200 acres in size. They are about 50 to 70 percent Barnes soil and 25 to 50 percent Buse soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the surface layer of the Barnes soil is black loam about 9 inches thick. The subsoil is loam about 20 inches thick. It is brown in the upper part and light olive brown and calcareous in the lower part. The next layer is light olive brown, calcareous loam about 14 inches thick. The substratum to a depth of about 60 inches is also light olive brown, calcareous loam. In some areas the dark color of the surface layer extends to a depth of more than 16 inches.

Typically, the surface layer of the Buse soil is very dark gray, calcareous loam about 7 inches thick. The subsoil is light olive brown, calcareous loam about 11 inches thick. The substratum to a depth of about 60 inches also is light olive brown, calcareous loam. In some eroded areas the surface layer is lighter in color. In other areas stones are on the surface.

Included with these soils in mapping are small areas of excessively drained Sioux soils. These included soils make up about 5 percent of the unit. They are on ridges.

Permeability is moderately slow in the Barnes and Buse soils. Runoff is rapid on the Barnes soil and very rapid on the Buse soil. Available water capacity is high in both soils. Organic matter content is high in the Barnes soil and moderately low in the Buse soil.

Most areas are used for range. These soils are best suited to this use. The hazard of soil blowing is moderate on the Buse soil and slight on the Barnes soil. The hazard of water erosion is very severe on both soils. These soils are generally unsuited to cultivated crops and pasture because of the hazards of soil blowing and water erosion and the slope.

In areas where these soils are used as range, the important native forage plants are needleandthread, western wheatgrass, green needlegrass, and little bluestem. Soil blowing and water erosion are hazards,

especially if the range is overgrazed. Maintaining an adequate cover of the important plants helps to control erosion. Gullies can form along cattle trails. A planned grazing system that controls the pattern of livestock traffic helps to prevent gullying.

These soils are generally unsuited to the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Trees and shrubs can be grown for esthetic purposes or to enhance wildlife habitat if special management, such as hand or scalp planting, is applied.

The land capability classification of the Barnes soil is VIe, and that of the Buse soil is VIIe. The productivity index of the unit for spring wheat is 0. The range site of the Barnes soil is Silty, and that of the Buse soil is Thin Upland.

29D—Buse-Svea loams, 9 to 15 percent slopes. These very deep, rolling, well drained soils are on moraines. The Buse soil is on shoulder slopes, knobs, and knolls. The Svea soil is on foot slopes and side slopes. Individual areas range from about 5 to 200 acres in size. They are about 45 to 65 percent Buse soil and 30 to 55 percent Svea soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the surface layer of the Buse soil is very dark gray, calcareous loam about 7 inches thick. The subsoil is light olive brown, calcareous loam about 11 inches thick. The substratum to a depth of about 60 inches also is light olive brown, calcareous loam. In some eroded areas the surface layer is lighter in color. In other areas the upper part of the subsoil is noncalcareous.

Typically, the surface soil of the Svea soil is black loam about 20 inches thick. The subsoil is loam about 12 inches thick. It is very dark grayish brown in the upper part and light yellowish brown and calcareous in the lower part. The substratum to a depth of about 60 inches is olive brown, mottled, calcareous loam. In some areas the dark color of the surface layer extends to a depth of only 8 to 16 inches.

Included with these soils in mapping are small areas of Hamerly and Parnell soils. These included soils make up about 5 percent of the unit. The somewhat poorly drained Hamerly soils are on flats. The very poorly drained Parnell soils are in depressions.

Permeability is moderately slow in the Buse and Svea soils. Runoff is rapid on the Buse soil and medium on the Svea soil. Available water capacity is high in both soils. Organic matter content is moderately low in the Buse soil and high in the Svea soil.

Most areas are used for cultivated crops, hay, or range. These soils are best suited to range, pasture, or hay. The hazard of soil blowing is moderate on the Buse soil and slight on the Svea soil. The hazard of water erosion is severe on both soils. These soils are generally unsuited to cultivated crops because of the hazards of soil blowing and water erosion and the slope. Establishing a cover of grasses in cultivated areas helps to maintain productivity and control erosion.

In areas where these soils are used for range, the important native forage plants are needleandthread, western wheatgrass, green needlegrass, and little bluestem. Alfalfa, sweetclover, intermediate wheatgrass, and smooth bromegrass are suitable hay and pasture plants. Soil blowing and water erosion are hazards, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable plants helps to control erosion. Gullies can form along cattle trails. A planned grazing system that controls the pattern of livestock traffic helps to prevent gullying.

The Buse soil is generally unsuited to the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Svea soil is suited to nearly all of the climatically adapted species. Trees and shrubs can be grown for esthetic purposes or to enhance wildlife habitat if special management, such as hand or scalp planting, is applied. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings.

The land capability classification of the Buse soil is VIe, and that of the Svea soil is IVe. The productivity index of the unit for spring wheat is 0. The range site of the Buse soil is Thin Upland, and that of the Svea soil is Silty. The pasture group of the Buse soil is Thin Upland, and that of the Svea soil is Loamy and Silty.

30C—Barnes-Maddock-Swenoda complex, 6 to 9 percent slopes. These very deep, gently rolling soils are on mantled till plains and moraines. The well drained Barnes soil is on the upper side slopes and summits. The well drained Maddock soil and the moderately well drained Swenoda soil are on the lower side slopes. Individual areas range from about 5 to 200 acres in size. They are about 50 to 65 percent Barnes soil, 15 to 30 percent Maddock soil, and 15 to 30 percent Swenoda soil. The three soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the surface layer of the Barnes soil is black loam about 9 inches thick. The subsoil is loam about 20 inches thick. It is brown in the upper part and light olive brown and calcareous in the lower part. The next layer is light olive brown, calcareous loam about 14 inches thick. The substratum to a depth of about 60 inches

also is light olive brown, calcareous loam. In some areas the subsoil is calcareous throughout.

Typically, the surface soil of the Maddock soil is black sandy loam about 12 inches thick. The subsoil is very dark brown loamy sand about 9 inches thick. The substratum to a depth of about 60 inches is olive brown sand. In some areas the soil has a substratum of loam at a depth of 20 to 40 inches. In other areas the substratum is mottled.

Typically, the surface soil of the Swenoda soil is black fine sandy loam about 11 inches thick. The subsoil is fine sandy loam about 21 inches thick. It is very dark grayish brown in the upper part and grayish brown and calcareous in the lower part. The substratum to a depth of about 60 inches is light olive brown, mottled, and calcareous. It is loamy fine sand in the upper part and silty clay loam in the lower part. In some areas the substratum is fine sandy loam.

Included with these soils in mapping are small areas of Kratka and Larson soils. These included soils make up about 5 percent of the unit. The poorly drained Kratka soils are in depressions. The somewhat poorly drained Larson soils are on flats.

Permeability is moderately slow in the Barnes soil and rapid in the Maddock soil. It is moderately rapid in the upper part of the Swenoda soil and moderately slow in the lower part. Runoff is rapid on the Barnes soil and medium on the Maddock and Swenoda soils. Available water capacity is high in the Barnes and Swenoda soils and moderate in the Maddock soil. The seasonal high water table is at a depth of 2.5 to 4.0 feet in the Swenoda soil. Organic matter content is high in the Barnes and Swenoda soils and moderate in the Maddock soil. Tilth of all three soils is good.

Most areas are used for cultivated crops, hay, pasture, or range. These soils are suited to cultivated crops and to grasses and legumes for hay and pasture. The hazard of soil blowing is slight on the Barnes soil and severe on the Maddock and Swenoda soils. The hazard of water erosion is severe on the Barnes soil and moderate on the Maddock and Swenoda soils. The main management concern in cultivated areas is controlling soil blowing and water erosion. A system of conservation tillage that leaves crop residue on the surface, field windbreaks, stripcropping, and grassed waterways in areas where runoff concentrates help to control erosion. Conservation tillage also provides food and cover for resident and migratory wildlife.

In areas where these soils are used for range, the important forage plants are needleandthread, western wheatgrass, green needlegrass, and prairie sandreed. Slender wheatgrass, intermediate wheatgrass, big bluestem, indiangrass, alfalfa, and sweetclover are suitable hay and pasture plants. Soil blowing and water erosion are hazards, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable plants helps to control erosion.

The Barnes soil is suited to nearly all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Maddock soil is suited to many of the climatically adapted species. The Swenoda soil is suited to all of the climatically adapted species. Because the Maddock soil is somewhat droughty, the trees and shrubs commonly are affected by moisture stress, particularly during the establishment period. Irrigation helps to ensure the survival of seedlings. Little benefit is derived from fallowing during the season prior to planting because of the moderate available water capacity. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs in areas of the Maddock and Swenoda soils help to control soil blowing and protect the seedlings from abrasion.

The land capability classification of the Barnes and Swenoda soils is IIIe, and that of the Maddock soil is IVe. The productivity index of the unit for spring wheat is 51. The range site of the Barnes soil is Silty, and that of the Maddock and Swenoda soils is Sandy. The pasture group of the Barnes soil is Loamy and Silty, and that of the Maddock and Swenoda soils is Sandy.

31—Fram-Parnell complex, 0 to 3 percent slopes. These very deep soils are on till plains. The level and nearly level, somewhat poorly drained, highly calcareous Fram soil is on flats and rises. The level, very poorly drained Parnell soil is in depressions. It is ponded. Individual areas of this unit range from about 5 to 500 acres in size. They are about 55 to 80 percent Fram soil and 20 to 40 percent Parnell soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the surface layer of the Fram soil is black, calcareous loam about 8 inches thick. The subsoil is calcareous loam about 15 inches thick. It is light brownish gray and mottled in the upper part and light olive brown and grayish brown in the lower part. The substratum to a depth of about 60 inches is olive brown, mottled, calcareous loam. In some areas the soil is poorly drained. In other areas it is moderately saline.

Typically, the surface layer of the Parnell soil is black silty clay loam about 9 inches thick. The subsoil is clay loam about 35 inches thick. It is dark olive gray in the upper part and olive gray and mottled in the lower part. The substratum to a depth of about 60 inches is olive gray, mottled clay loam. In some areas the soil has a

subsurface layer that is light in color and is mottled. In other areas the surface layer is silt loam.

Included with these soils in mapping are small areas of Larson soils and the saline Vallers soils. These included soils make up about 5 percent of the unit. The Larson soils have a sodic subsoil. They are intermingled with areas of the Fram soil. The poorly drained Vallers soils are on flats.

Permeability is moderate in the Fram soil and slow in the Parnell soil. Runoff is slow on the Fram soil and ponded on the Parnell soil. Available water capacity is high in both soils. The seasonal high water table is at a depth of 2 to 6 feet in the Fram soil and 2 feet above to 2 feet below the surface in the Parnell soil. Organic matter content is high in both soils. Tilth is good.

Most areas are used for cultivated crops, range, hay, or wetland wildlife habitat. The Fram soil and drained areas of the Parnell soil are suited to cultivated crops and to grasses and legumes for hay and pasture. The hazard of soil blowing is moderate on the Fram soil and slight on the Parnell soil. The hazard of water erosion is slight on both soils. The main management concerns in cultivated areas are soil blowing on the Fram soil and the wetness in areas of the Parnell soil. A drainage system in areas of the Parnell soil increases the suitability of the soil for cultivated crops; however, locating suitable drainage outlets is difficult. In undrained areas crops are planted and harvested in only about 2 years out of 10. A system of conservation tillage that leaves crop residue on the surface, field windbreaks, and stripcropping help to control soil blowing. Conservation tillage also provides food and cover for resident and migratory wildlife.

Areas of the Parnell soil and the ponded water provide excellent winter cover for resident wildlife and high-quality feeding, breeding, and rearing sites for wetland wildlife. The main concerns in managing wetland wildlife habitat are maintaining the natural wetness and preventing siltation.

In areas where these soils are used for range, the important native forage plants are little bluestem, big bluestem, slough sedge, and rivergrass. Smooth bromegrass, tall wheatgrass, intermediate wheatgrass, sweetclover, and alfalfa are suitable hay and pasture plants on the Fram soil. If the Parnell soil is drained, reed canarygrass, big bluestem, and alsike clover are suitable plants. Compaction, trampling, and root shearing are problems in areas of the Parnell soil, especially if the range or pasture is grazed when the soil is wet. The soil blowing is a hazard, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable plants helps to control soil blowing.

The Fram soil and drained areas of the Parnell soil are suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Undrained areas of the Parnell soil generally are unsuited to the climatically adapted species. The wetness and the ponding are critical limitations affecting survival, growth, and vigor. The grasses and weeds growing on these soils are abundant and persistent. Eliminating this ground cover before the trees and shrubs are planted and then controlling the regrowth of this cover improve the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs in areas of the Fram soil help to control soil blowing and protect the seedlings from abrasion.

The land capability classification of the Fram soil is IIe, and that of the Parnell soil is IIIw. The productivity index of the unit for spring wheat is 64 to 79, depending on the degree of drainage in areas of the Parnell soil. The range site of the Hamerly soil is Limy Subirrigated, and that of the Parnell soil is Wetland. The pasture group of the Hamerly soil is Limy Subirrigated, and that of drained areas of the Parnell soil is Wet.

33—Fram-Wyard loams, 0 to 3 percent slopes. These very deep, somewhat poorly drained soils are on till plains. The level and nearly level, highly calcareous Fram soil is on rises. The level Wyard soil is in swales. Individual areas range from about 5 to 1,000 acres in size. They are about 55 to 65 percent Fram soil and 20 to 30 percent Wyard soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the surface layer of the Fram soil is black, calcareous loam about 8 inches thick. The subsoil is calcareous loam about 15 inches thick. It is light brownish gray and mottled in the upper part and light olive brown and grayish brown in the lower part. The substratum to a depth of about 60 inches is olive brown, mottled, calcareous loam. In some areas the soil is poorly drained. In other ares the subsoil is silt loam.

Typically, the surface layer of the Wyard soil is black loam about 8 inches thick. The subsoil is loam about 22 inches thick. It is very dark brown and mottled in the upper part, dark grayish brown in the next part, and grayish brown and calcareous in the lower part. The substratum to a depth of about 60 inches is olive brown, mottled, calcareous loam. In some areas the subsoil is not mottled.

Included with these soils in mapping are small areas of Cathay, Heimdal, Parnell, and Tonka soils. These included soils make up about 15 percent of the unit. The Cathay and Heimdal soils are on rises. The Cathay soils are moderately well drained. The Heimdal soils are well drained. The Parnell and Tonka soils are in

depressions. The Parnell soils are very poorly drained. The Tonka soils are poorly drained.

Permeability is moderate in the Fram and Wyard soils. Runoff is slow. Available water capacity is high. The seasonal high water table is at a depth of 2 to 6 feet in the Fram soil and at a depth of 1 to 3 feet in the Wyard soil. Organic matter content is high in both soils. Tilth is good.

Most areas are used for cultivated crops. These soils are suited to cultivated crops and range and to grasses and legumes for hay and pasture. The hazard of soil blowing is moderate on the Fram soil and slight on the Wyard soil. The hazard of water erosion is slight on both soils. The main management concerns in cultivated areas are controlling soil blowing on the Fram soil and overcoming the early season wetness of the Wyard soil. A system of conservation tillage that leaves crop residue on the surface, field windbreaks, and stripcropping help to control soil blowing. Delaying tillage and planting helps to overcome the early season wetness. Conservation tillage also provides food and cover for resident and migratory wildlife.

In areas where these soils are used for range, the important native forage plants are little bluestem, big bluestem, green needlegrass, and needleandthread. Smooth bromegrass, tall wheatgrass, intermediate wheatgrass, sweetclover, and alfalfa are suitable hay and pasture plants. The soil blowing is a hazard, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable plants helps to control soil blowing.

These soils are suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs in areas of the Fram soil help to control soil blowing and protect the seedlings from abrasion.

The land capability classification of the Fram soil is IIe, and that of the Wyard soil is IIw. The productivity index of the unit for spring wheat is 83. The range site of the Fram soil is Limy Subirrigated, and that of the Wyard soil is Overflow. The pasture group of the Fram soil is Limy Subirrigated, and that of the Wyard soil is Overflow and Run-on.

36—Heimdal-Emrick loams, 0 to 3 percent slopes. These very deep, level and nearly level soils are on till plains. The well drained Heimdal soil is on rises. The moderately well drained Emrick soil is in swales. Individual areas range from about 5 to 500 acres in size. They are about 55 to 65 percent Heimdal soil and 30 to 45 percent Emrick soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the surface layer of the Heimdal soil is black loam about 7 inches thick. The subsoil is loam about 23 inches thick. It is dark brown in the upper part and light olive brown and calcareous in the lower part. The substratum to a depth of about 60 inches is olive brown, calcareous loam. In some areas the subsoil is calcareous throughout.

Typically, the surface soil of the Emrick soil is black loam about 16 inches thick. The subsoil is loam about 27 inches thick. It is very dark grayish brown in the upper part and olive brown and calcareous in the lower part. The substratum to a depth of about 60 inches is olive brown, mottled, calcareous loam. In some areas the soil has an accumulation of lime within a depth of 16 inches.

Included with these soils in mapping are small areas of Cathay and Tonka soils. These included soils make up about 5 percent of the unit. The Cathay soils have a sodic subsoil. They are intermingled with areas of the Emrick soil. The poorly drained Tonka soils are in depressions.

Permeability is moderate in the Heimdal and Emrick soils. Runoff is slow. Available water capacity is high. Organic matter content also is high. Tilth is good.

Most areas are used for cultivated crops. These soils are well suited to cultivated crops and range and to grasses and legumes for hay and pasture. The hazards of soil blowing and water erosion are slight. Soil blowing occurs during some storms. The main management concern in cultivated areas is controlling soil blowing. A system of conservation tillage that leaves crop residue on the surface, field windbreaks, and stripcropping help to control soil blowing. Conservation tillage also provides food and cover for resident and migratory wildlife.

In areas where these soils are used for range, the important native forage plants are big bluestem, green needlegrass, western wheatgrass, and needleandthread. Smooth bromegrass, intermediate wheatgrass, big bluestem, switchgrass, alfalfa, and sweetclover are suitable hay and pasture plants. No major hazards affect the use of these soils as range or pasture.

The Heimdal soil is suited to nearly all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Emrick soil is suited to all of the climatically adapted species. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings.

The land capability classification of both soils is IIe. The productivity index of the unit for spring wheat is 82. The range site of the Heimdal soil is Silty, and that of the Emrick soil is Overflow. The pasture group of the Heimdal soil is Loamy and Silty, and that of the Emrick soil is Overflow and Run-on.

36B—Heimdal-Emrick loams, 3 to 6 percent slopes. These very deep, undulating soils are on till plains. The well drained Heimdal soil is on rises. The moderately well drained Emrick soil is in swales. Individual areas range from about 5 to 400 acres in size. They are about 65 to 75 percent Heimdal soil and 20 to 35 percent Emrick soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the surface layer of the Heimdal soil is black loam about 7 inches thick. The subsoil is loam about 23 inches thick. It is dark brown in the upper part and light olive brown and calcareous in the lower part. The substratum to a depth of about 60 inches is olive brown, calcareous loam. In some areas the subsoil is calcareous throughout.

Typically, the surface soil of the Emrick soil is black loam about 16 inches thick. The subsoil is loam about 27 inches thick. It is very dark grayish brown in the upper part and olive brown and calcareous in the lower part. The substratum to a depth of about 60 inches is olive brown, mottled, calcareous loam. In some areas the soil has an accumulation of lime within a depth of 16 inches.

Included with these soils in mapping are small areas of Cathay and Tonka soils. These included soils make up about 5 percent of the unit. The Cathay soils have a sodic subsoil. They are intermingled with areas of the Emrick soil. The poorly drained Tonka soils are in depressions.

Permeability is moderate in the Heimdal and Emrick soils. Runoff is medium on the Heimdal soil and slow on the Emrick soil. Available water capacity is high in both soils. Organic matter content also is high. Tilth is good.

Most areas are used for cultivated crops. These soils are suited to cultivated crops and range and to grasses and legumes for hay and pasture. The hazard of soil blowing is slight. Soil blowing occurs during some storms. The hazard of water erosion is moderate. The main management concern in cultivated areas is controlling soil blowing and water erosion. A system of conservation tillage that leaves crop residue on the surface, field windbreaks, stripcropping, and grassed waterways in areas where runoff concentrates help to control erosion. Conservation tillage also provides food and cover for resident and migratory wildlife.

In areas where these soils are used for range, the important native forage plants are western wheatgrass, green needlegrass, and needleandthread. Smooth bromegrass, intermediate wheatgrass, alfalfa, and sweetclover are suitable hay and pasture plants. Water erosion is a hazard, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable plants helps to control water erosion.

The Heimdal soil is suited to nearly all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Emrick soil is suited to all of the climatically adapted species. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings.

The land capability classification of both soils is IIe. The productivity index of the unit for spring wheat is 72. The range site of both soils is Silty. The pasture group is Loamy and Silty.

37B—Heimdal-Esmond loams, 3 to 6 percent slopes. These very deep, undulating, well drained soils are on till plains. The Heimdal soil is on flats and rises. The Esmond soil is on knobs and knolls. Individual areas range from about 5 to 1,000 acres in size. They are about 35 to 55 percent Heimdal soil and 25 to 45 percent Esmond soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the surface layer of the Heimdal soil is black loam about 7 inches thick. The subsoil is loam about 23 inches thick. It is dark brown in the upper part and light olive brown and calcareous in the lower part. The substratum to a depth of about 60 inches is olive brown, calcareous loam. In some areas the dark color of the surface layer extends to a depth of more than 16 inches.

Typically, the surface layer of the Esmond soil is black, calcareous loam about 7 inches thick. The subsoil is dark grayish brown, calcareous loam about 4 inches thick. The substratum to a depth of about 60 inches is olive brown, calcareous loam.

Included with these soils in mapping are small areas of Cathay, Fram, and Tonka soils. These included soils make up about 20 percent of the unit. The moderately well drained Cathay soils are in swales. The somewhat poorly drained Fram soils are on flats. The poorly drained Tonka soils are in depressions.

Permeability is moderate in the Heimdal and Esmond soils. Runoff is medium. Available water capacity is high. Organic matter content is high in the Heimdal soil and moderately low in the Esmond soil. Tilth of both soils is good.

Most areas are used for cultivated crops. These soils are suited to cultivated crops and range and to grasses and legumes for hay and pasture. The hazard of soil blowing is moderate on the Esmond soil and slight on the Heimdal soil. The hazard of water erosion is moderate on both soils. The main management concern in cultivated areas is controlling soil blowing and water erosion. A system of conservation tillage that leaves crop residue on the surface, field windbreaks, stripcropping, and grassed waterways in areas where runoff concentrates help to control erosion. Conservation tillage also provides food and cover for resident and migratory wildlife.

In areas where these soils are used for range, the important native forage plants are western wheatgrass, green needlegrass, little bluestem, and needleandthread. Smooth bromegrass, intermediate wheatgrass, little bluestem, green needlegrass, alfalfa, and sweetclover are suitable hay and pasture plants. Soil blowing and water erosion are hazards, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable plants helps to control erosion.

The Heimdal soil is suited to nearly all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Esmond soil is suited to only the most drought-tolerant species. Optimum growth, survival, and vigor are unlikely on the Esmond soil. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs in areas of the Esmond soil help to control soil blowing and protect the seedlings from abrasion.

The land capability classification of the Heimdal soil is IIe, and that of the Esmond soil is IIIe. The productivity index of the unit for spring wheat is 63. The range site of the Heimdal soil is Silty, and that of the Esmond soil is Thin Upland. The pasture group of the Heimdal soil is Loamy and Silty, and that of the Esmond soil is Thin Upland.

37C—Heimdal-Esmond loams, 6 to 9 percent slopes. These very deep, gently rolling, well drained soils are on till plains. The Heimdal soil is on rises. The Esmond soil is on knobs and knolls. Individual areas range from about 5 to 200 acres in size. They are about 60 to 75 percent Heimdal soil and 25 to 40 percent Esmond soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the surface layer of the Heimdal soil is black loam about 7 inches thick. The subsoil is loam about 23 inches thick. It is dark brown in the upper part and light olive brown and calcareous in the lower part. The substratum to a depth of about 60 inches is olive brown, calcareous loam. In some areas the dark color of the surface layer extends to a depth of more than 16 inches.

Typically, the surface layer of the Esmond soil is black, calcareous loam about 7 inches thick. The subsoil is dark grayish brown, calcareous loam about 4 inches thick. The substratum to a depth of about 60 inches is olive brown, calcareous loam. In some eroded areas the surface layer is lighter in color.

Included with these soils in mapping are small areas of Arvilla, Fram, and Parnell soils. These included soils make up about 5 percent of the unit. The somewhat excessively drained Arvilla soils are on ridges. The somewhat poorly drained Fram soils are on flats. The very poorly drained Parnell soils are in depressions.

Permeability is moderate in the Heimdal and Esmond soils. Runoff is medium on the Heimdal soil and rapid on the Esmond soil. Available water capacity is high in both soils. Organic matter content is high in the Heimdal soil and moderately low in the Esmond soil. Tilth of both soils is good.

Most areas are used for cultivated crops. These soils are suited to cultivated crops and range and to grasses and legumes for hay and pasture. The hazard of soil blowing is moderate on the Esmond soil and slight on the Heimdal soil. The hazard of water erosion is severe on both soils. The main management concern in cultivated areas is controlling soil blowing and water erosion. A system of conservation tillage that leaves crop residue on the surface, field windbreaks, stripcropping, and grassed waterways in areas where runoff concentrates help to control erosion. Conservation tillage also provides food and cover for resident and migratory wildlife.

In areas where these soils are used for range, the important native forage plants are needleandthread, little bluestem, western wheatgrass, and green needlegrass. Smooth bromegrass, intermediate wheatgrass, green needlegrass, little bluestem, alfalfa, and sweetclover are suitable hay and pasture plants. Soil blowing and water erosion are hazards, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable plants helps to control erosion.

The Heimdal soil is suited to nearly all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Esmond soil is suited to only the most drought-tolerant species. Optimum growth, survival, and vigor are unlikely on the Esmond soil. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the

regrowth of this ground cover improve the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs in areas of the Esmond soil help to control soil blowing and protect the seedlings from abrasion.

The land capability classification of the Heimdal soil is IIIe, and that of the Esmond soil is IVe. The productivity index of the unit for spring wheat is 55. The range site of the Heimdal soil is Silty, and that of the Esmond soil is Thin Upland. The pasture group of the Heimdal soil is Loamy and Silty, and that of the Esmond soil is Thin Upland.

38F—Heimdal-Esmond loams, 15 to 35 percent slopes. These very deep, well drained soils are on valley side slopes and moraines. The hilly Heimdal soil is on side slopes. The hilly and steep Esmond soil is on shoulder slopes and summits. Individual areas range from about 5 to 200 acres in size. They are about 50 to 65 percent Heimdal soil and 25 to 40 percent Esmond soil. A few stones are on the surface in some areas. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the surface layer of the Heimdal soil is black loam about 7 inches thick. The subsoil is loam about 23 inches thick. It is dark brown in the upper part and light olive brown and calcareous in the lower part. The substratum to a depth of about 60 inches is olive brown, calcareous loam. In some areas the dark color of the surface layer extends to depth of more than 16 inches. In other areas the substratum is sandy loam.

Typically, the surface layer of the Esmond soil is black, calcareous loam about 7 inches thick. The subsoil is dark grayish brown, calcareous loam about 4 inches thick. The substratum to a depth of about 60 inches is olive brown, calcareous loam. In some eroded areas the surface layer is lighter in color. In other areas the substratum is silt loam.

Included with these soils in mapping are small areas of La Prairie and Sioux soils. These included soils make up about 10 percent of the unit. The moderately well drained La Prairie soils are in drainageways. The excessively drained Sioux soils are on ridges.

Permeability is moderate in the Heimdal and Esmond soils. Runoff is rapid on the Heimdal soil and very rapid on the Esmond soil. Available water capacity is high in both soils. Organic matter content is high in the Heimdal soil and moderately low in the Esmond soil.

Most areas are used for range. These soils are best suited to this use. The hazard of soil blowing is moderate on the Esmond soil and slight on the Heimdal soil. The hazard of water erosion is very severe on both soils. These soils are generally unsuited to cultivated crops and pasture because of the hazards of soil blowing and water erosion and the slope.

In areas where these soils are used as range, the important native forage plants are needleandthread, western wheatgrass, green needlegrass, and little bluestem. Soil blowing and water erosion are hazards, especially if the range is overgrazed. Maintaining an adequate cover of the important forage plants helps to control erosion. Gullies can form along cattle trails. A planned grazing system that controls the pattern of livestock traffic helps to prevent gullying.

These soils are generally unsuited to the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Trees and shrubs can be grown for esthetic purposes or to enhance wildlife habitat if special management, such as hand or scalp planting, is applied.

The land capability classification of the Heimdal soil is VIe, and that of the Esmond soil is VIIe. The productivity index of the unit for spring wheat is 0. The range site of the Heimdal soil is Silty, and that of the Esmond soil is Thin Upland.

39D—Heimdal-Esmond loams, 9 to 15 percent slopes. These very deep, rolling, well drained soils are on till plains and moraines. The Heimdal soil is on side slopes. The Esmond soil is on shoulder slopes and summits. Individual areas range from about 5 to 200 acres in size. They are about 45 to 65 percent Heimdal soil and 35 to 50 percent Esmond soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the surface layer of the Heimdal soil is black loam about 7 inches thick. The subsoil is loam about 23 inches thick. It is dark brown in the upper part and light olive brown and calcareous in the lower part. The substratum to a depth of about 60 inches is olive brown, calcareous loam. In some areas the dark color of the surface soil extends to depth of more than 16 inches. In other areas the substratum is sandy loam.

Typically, the surface layer of the Esmond soil is black, calcareous loam about 7 inches thick. The subsoil is dark grayish brown, calcareous loam about 4 inches thick. The substratum to a depth of about 60 inches is olive brown, calcareous loam. In some areas the surface layer is lighter in color. In other areas the substratum is silt loam.

Included with these soils in mapping are small areas of Parnell and Sioux soils. These included soils make up about 5 percent of the unit. The very poorly drained Parnell soils are in depressions. The excessively drained Sioux soils are on ridges.

Permeability is moderate in the Heimdal and Esmond

soils. Runoff is rapid. Available water capacity is high. Organic matter content is high in the Heimdal soil and moderately low in the Esmond soil. Tilth of both soils is good.

Most areas are used for cultivated crops, hay, or range. These soils are poorly suited to cultivated crops because of the hazards of water erosion and soil blowing and the slope. They are better suited to range, hay, and pasture. The hazard of soil blowing is moderate on the Esmond soil and slight on the Heimdal soil. The hazard of water erosion is severe on both soils. The main management concern in cultivated areas is controlling soil blowing and water erosion. A system of conservation tillage that leaves crop residue on the surface, field windbreaks, stripcropping, and grassed waterways in areas where runoff concentrates help to control erosion. Conservation tillage also provides food and cover for resident and migratory wildlife.

In areas where these soils are used for range, the important native forage plants are needleandthread, western wheatgrass, green needlegrass, and little bluestem. Alfalfa, sweetclover, intermediate wheatgrass, little bluestem, green needlegrass, and smooth bromegrass are suitable hay and pasture plants. Water erosion and soil blowing are hazards, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable plants helps to control erosion. Gullies can form along cattle trails. A planned grazing system that controls the pattern of livestock traffic helps to prevent gullying.

The Heimdal soil is suited to nearly all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Esmond soil is generally unsuited to the climatically adapted species. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings. Trees and shrubs can be grown for esthetic purposes or to enhance wildlife habitat if special management, such as hand or scalp planting, is applied.

The land capability classification of the Heimdal soil is IVe, and that of the Esmond soil is VIe. The productivity index of the unit for spring wheat is 27. The range site of the Heimdal soil is Silty, and that of the Esmond soil is Thin Upland. The pasture group of the Heimdal soil is Loamy and Silty, and that of the Esmond soil is Thin Upland.

41B—Embden fine sandy loam, 0 to 6 percent slopes. This very deep, level to gently sloping, moderately well drained soil is on flats and rises on outwash plains and lake plains. Individual areas range from about 5 to 200 acres in size.

Typically, the surface soil is black fine sandy loam about 17 inches thick. The subsoil is fine sandy loam about 23 inches thick. It is very dark gray in the upper part and dark grayish brown in the lower part. The substratum to a depth of about 60 inches is light olive brown, mottled, calcareous fine sand. In some areas the dark color of the surface soil extends to a depth of only 7 to 16 inches. In other areas the substratum is loam, clay loam, or sand.

Included with this soil in mapping are small areas of Arvilla, Divide, and Maddock soils. These soils make up about 15 percent of the unit. The Arvilla and Maddock soils are intermingled with areas of the Embden soil. The Arvilla soils are somewhat excessively drained. The Maddock soils are well drained. The somewhat poorly drained Divide soils are on flats.

Permeability is moderately rapid in the Embden soil, and runoff is slow. Available water capacity is moderate. The seasonal high water table is at a depth of 4 to 6 feet. Organic matter content is high. Tilth is good.

Most areas are used for cultivated crops. This soil is suited to cultivated crops and to grasses and legumes for hay and pasture. The hazard of soil blowing is severe, and the hazard of water erosion is slight. The main management concern in cultivated areas is controlling soil blowing. A system of conservation tillage that leaves crop residue on the surface, field windbreaks, and stripcropping help to control soil blowing. Conservation tillage also provides food and cover for resident and migratory wildlife.

In areas where this soil is used for range, the important native forage plants are prairie sandreed, needleandthread, and western wheatgrass. Intermediate wheatgrass, slender wheatgrass, green needlegrass, sweetclover, and alfalfa are suitable hay and pasture plants. The soil blowing is a hazard, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable plants helps to control soil blowing.

This soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification is IIIe. The productivity index for spring wheat is 67. Both the range site and the pasture group are Sandy.

42—Wyndmere-Arveson complex, loamy substratum, 0 to 3 percent slopes. These very deep, highly calcareous soils are on outwash plains and lake plains. The somewhat poorly drained, level and nearly level Wyndmere soil is on rises. The poorly drained, level Arveson soil is on flats and in swales. Individual areas range from about 5 to 200 acres in size. They are about 55 to 70 percent Wyndmere soil and 15 to 25 percent Arveson soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the surface soil of the Wyndmere soil is calcareous fine sandy loam about 11 inches thick. It is black in the upper part and very dark brown in the lower part. The subsoil is calcareous fine sandy loam about 18 inches thick. It is very dark grayish brown in the upper part, dark grayish brown in the next part, and light brownish gray in the lower part. The substratum to a depth of about 60 inches is light olive brown, mottled, and calcareous. It is loamy fine sand in the upper part, fine sand in the next part, and clay loam in the lower part. In some areas the subsoil is loam. In other areas the soil has sand at a depth of 20 to 40 inches.

Typically, the surface soil of the Arveson soil is calcareous loam about 11 inches thick. It is black in the upper part and very dark gray in the lower part. The subsoil is gray and calcareous. It is about 15 inches thick. It is sandy clay loam in the upper part and sandy loam in the lower part. The substratum to a depth of about 60 inches is olive gray, mottled, and calcareous. It is loamy fine sand in the upper part and clay loam in the lower part. In some areas the subsoil is loam. In other areas, the soil has a substratum of loam at a depth of 20 to 40 inches or the substratum is loamy sand throughout.

Included with these soils in mapping are small areas of Letcher, Manfred, Tonka, and Towner soils. These included soils make up about 20 percent of the unit. The moderately well drained Letcher and Towner soils are on rises. The Manfred and Tonka soils are in depressions. The Manfred soils have a sodic subsoil. The Tonka soils have an accumulation of clay in the subsoil.

Permeability is moderately rapid in the upper part of the Wyndmere and Arveson soils and moderately slow in the lower part. Runoff is slow. Available water capacity is moderate in the Wyndmere soil and high in the Arveson soil. The seasonal high water table is at a depth of 2 to 5 feet in the Wyndmere soil and within a depth of 2 feet in the Arveson soil. Organic matter content is high in both soils. Tilth is good.

Most areas are used for cultivated crops. Some areas are used for hay or pasture. These soils are suited to cultivated crops and range and to grasses and legumes for hay and pasture. The hazard of soil blowing is severe on the Wyndmere soil and moderate on the Arveson soil. The hazard of water erosion is slight on both soils. The main management concerns in cultivated areas are controlling soil blowing on both soils and overcoming the early season wetness of the Arveson soil. A drainage system in areas of the Arveson soil increases the suitability of the soil for cultivated crops; however, locating suitable drainage outlets is difficult. In undrained areas crops are grown in only about 5 to 7 years out of 10. A system of conservation tillage that leaves crop residue on the surface, field windbreaks, and stripcropping help to control soil blowing. Conservation tillage also provides food and cover for resident and migratory wildlife.

In areas where these soils are used for range, the important native forage plants are little bluestem, big bluestem, and switchgrass. Creeping foxtail, big bluestem, reed canarygrass, tall wheatgrass, sweetclover, and alsike clover are suitable hay and pasture plants. Compaction, trampling, and root shearing are problems, especially if the range or pasture is grazed when the Arveson soil is wet. Grazing should be deferred during wet periods. The soil blowing is a hazard, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable plants helps to control soil blowing.

The Wyndmere soil and drained areas of the Arveson soil are suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Undrained areas of the Arveson soil generally are unsuited to the climatically adapted species. The wetness is a critical limitation affecting survival, growth, and vigor. The grasses and weeds growing on these soils are abundant and persistent. Eliminating this ground cover before the trees and shrubs are planted and then controlling the regrowth of this cover improve the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification of the Wyndmere soil is IIIe, and that of the Arveson soil is IIw. The productivity index of the unit for spring wheat is 63 to 67, depending on the degree of drainage on the Arveson soil. The range site of the Wyndmere soil is Limy Subirrigated, and that of the Arveson soil is Subirrigated. The pasture group of the Wyndmere soil is Limy Subirrigated, and that of the Arveson soil is Wet.

51—Bearden silty clay loam, sandy substratum. This very deep, level, somewhat poorly drained, highly calcareous soil is on flats on lake plains. Individual areas range from about 5 to 100 acres in size.

Typically, the surface layer is black, calcareous silty clay loam about 8 inches thick. The next layer is very dark gray, calcareous silty clay loam about 3 inches thick. The subsoil is about 24 inches thick. It is gray, calcareous silty clay loam in the upper part and light olive brown, mottled, calcareous silt loam in the lower part. The substratum to a depth of about 60 inches is light olive brown, mottled, and calcareous. It is silt loam in the upper part and sand in the lower part. In some areas the subsoil is not highly calcareous.

Included with this soil in mapping are small areas of Parnell and Wyndmere soils. These soils make up about 10 percent of the unit. The very poorly drained Parnell soils are in depressions. The Wyndmere soils have a surface layer of fine sandy loam. They are intermingled with areas of the Bearden soil.

Permeability is moderately slow in the upper part of the Bearden soil and rapid in the lower part. Runoff is slow. Available water capacity is high. The seasonal high water table is at a depth of 2 to 4 feet. Organic matter content is high. Tilth is good.

Most areas are used for cultivated crops. Some areas are used for pasture or hay. This soil is suited to cultivated crops and range and to grasses and legumes for hay and pasture. The hazard of soil blowing is moderate, and the hazard of water erosion is slight. The main management concern in cultivated areas is controlling soil blowing. A system of conservation tillage that leaves crop residue on the surface, field windbreaks, and stripcropping help to control soil blowing. Conservation tillage also provides food and cover for resident and migratory wildlife.

In areas where this soil is used for range, the important native forage plants are little bluestem, switchgrass, and big bluestem. Tall wheatgrass, intermediate wheatgrass, big bluestem, indiangrass, sweetclover, and alfalfa are suitable hay and pasture plants. The soil blowing is a hazard, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable plants helps to control soil blowing.

This soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification is IIe. The productivity index for spring wheat is 90. Both the range site and the pasture group are Limy Subirrigated.

52—Glyndon loam, 0 to 2 percent slopes. This very deep, level and nearly level, somewhat poorly drained, highly calcareous soil is on flats on lake plains. Individual areas range from about 5 to 200 acres in size.

Typically, the surface soil is black, calcareous loam about 13 inches thick. The subsoil is calcareous silt loam about 20 inches thick. It is dark grayish brown in the upper part, light brownish gray in the next part, and light yellowish brown in the lower part. The substratum to a depth of about 60 inches is mottled, calcareous silt loam. It is light olive brown in the upper part and light yellowish brown in the lower part. In some areas the subsoil is not highly calcareous. In other areas the surface texture is silt loam.

Included with this soil in mapping are small areas of Embden, Maddock, and Wyndmere soils. These soils make up about 20 percent of the unit. They have more sand throughout the profile than the Glyndon soil. The moderately well drained Embden and the well drained Maddock soils are on rises. The Wyndmere soils are intermingled with areas of the Glyndon soil.

Permeability is moderate in the Glyndon soil, and runoff is slow. Available water capacity is high. The seasonal high water table is at a depth of 2.5 to 6.0 feet. Organic matter content is high. Tilth is good.

Most areas are used for cultivated crops. Some areas are used for pasture or hay. This soil is suited to cultivated crops and range and to grasses and legumes for hay and pasture. The hazard of soil blowing is moderate, and the hazard of water erosion is slight. The main management concern in cultivated areas is controlling soil blowing. A system of conservation tillage that leaves crop residue on the surface, field windbreaks, and stripcropping help to control soil blowing. Conservation tillage also provides food and cover for resident and migratory wildlife.

In areas where this soil is used for range, the important native forage plants are little bluestem, switchgrass, and big bluestem. Tall wheatgrass, intermediate wheatgrass, big bluestem, indiangrass, sweetclover, and alfalfa are suitable hay and pasture plants. The soil blowing is a hazard, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable plants helps to control soil blowing.

This soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and

shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification is IIe. The productivity index for spring wheat is 89. Both the range site and the pasture group are Limy Subirrigated.

60—Cathay-Heimdal loams, 1 to 3 percent slopes. These very deep, nearly level soils are on till plains. The moderately well drained, sodic Cathay soil is in swales. The well drained Heimdal soil is on rises. Individual areas range from about 5 to 200 acres in size. They are about 40 to 55 percent Cathay soil and 30 to 45 percent Heimdal soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the surface layer of the Cathay soil is black loam about 8 inches thick. The subsoil is about 32 inches thick. It is very dark grayish brown clay loam in the upper part; light brownish gray, mottled, calcareous loam in the next part; and olive brown, mottled, calcareous loam in the lower part. The substratum to a depth of about 60 inches is olive brown, mottled, calcareous loam.

Typically, the surface layer of the Heimdal soil is black loam about 7 inches thick. The subsoil is loam about 23 inches thick. It is dark brown in the upper part and light olive brown and calcareous in the lower part. The substratum to a depth of about 60 inches is olive brown, calcareous loam. In some areas the dark color of the surface layer extends to a depth of more than 16 inches.

Included with these soils in mapping are small areas of Fram, Miranda, and Tonka soils. These included soils make up about 20 percent of the unit. The somewhat poorly drained Fram and Miranda soils are on flats. The poorly drained Tonka soils are in depressions.

Permeability is moderately slow in the Cathay soil and moderate in the Heimdal soil. Runoff is slow on both soils. Available water capacity is high. The dense subsoil of the Cathay soil restricts the rooting depth of plants. The seasonal high water table is at a depth of 3 to 5 feet in the Cathay soil. Organic matter content is high in both soils. Tilth is fair.

Most areas are used for cultivated crops. Some areas are used for hay or pasture. These soils are suited to cultivated crops and range and to grasses and legumes for hay and pasture. The hazards of soil blowing and water erosion are slight. The dense subsoil in areas of the Cathay soil adversely affects crop production by restricting root penetration and by inhibiting moisture use. The main management concerns in cultivated areas are maintaining or improving tilth, improving root penetration in areas of the Cathay soil, and controlling erosion. A cropping system that includes deep-rooted legumes improves root penetration and tilth in the Cathay soil. A system of conservation tillage that leaves crop residue on the surface helps to control erosion, maintain or improve tilth, and provide food and cover for resident and migratory wildlife.

In areas where these soils are used for range, the important native forage plants are western wheatgrass, green needlegrass, and needleandthread. Smooth bromegrass, switchgrass, big bluestem, alfalfa, and sweetclover are suitable hay and pasture plants. No major hazards affect the use of these soils as range or pasture.

The Cathay soil is suited to many of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Heimdal soil is suited to nearly all of the climatically adapted species. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings. Individual trees and shrubs growing in areas of the Cathay soil vary in height, density, and vigor, which are affected by restricted root development in the dense subsoil and the reduced amount of available water caused by the salts in the soil.

The land capability classification of the Cathay soil is IIIs, and that of the Heimdal soil is IIe. The productivity index of the unit for spring wheat is 75. The range site of the Cathay soil is Clayey, and that of the Heimdal soil is Silty. The pasture group of the Cathay soil is Clayey Subsoil, and that of the Heimdal soil is Loamy and Silty.

60B—Heimdal-Cathay loams, 3 to 6 percent slopes. These very deep, undulating soils are on till plains. The well drained Heimdal soil is on rises. The moderately well drained, sodic Cathay soil is in swales. Individual areas range from about 5 to 100 acres in size. They are about 50 to 70 percent Heimdal soil and 25 to 45 percent Cathay soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the surface layer of the Heimdal soil is black loam about 7 inches thick. The subsoil is loam about 23 inches thick. It is dark brown in the upper part and light olive brown and calcareous in the lower part. The substratum to a depth of about 60 inches is olive brown, calcareous loam. In some areas the dark color of the surface layer extends to a depth of more than 16 inches.

Typically, the surface layer of the Cathay soil is black loam about 8 inches thick. The subsoil is about 32 inches thick. It is very dark grayish brown clay loam in the upper part; light brownish gray, mottled, calcareous

loam in the next part; and olive brown, mottled, calcareous loam in the lower part. The substratum to a depth of about 60 inches is olive brown, mottled, calcareous loam.

Included with these soils in mapping are small areas of Fram, Miranda, and Tonka soils. These included soils make up about 5 percent of the unit. The somewhat poorly drained Fram and Miranda soils are on flats. The poorly drained Tonka soils are in depressions.

Permeability is moderate in the Heimdal soil and moderately slow in the Cathay soil. Runoff is medium on both soils. Available water capacity is high. The dense subsoil of the Cathay soil restricts the rooting depth of plants. The seasonal high water table is at a depth of 3 to 5 feet in the Cathay soil. Organic matter content is high in both soils. Tilth is fair.

Most areas are used for cultivated crops. Some areas are used for hay or pasture. These soils are suited to cultivated crops and range and to grasses and legumes for hay and pasture. The hazard of soil blowing is slight, and the hazard of water erosion is moderate. The dense subsoil in areas of the Cathay soil adversely affects crop production in most years by restricting root penetration and by inhibiting moisture use. The main management concerns in cultivated areas are maintaining or improving tilth, improving root penetration in areas of the Cathay soil, and controlling water erosion. A cropping system that includes deep-rooted legumes improves root penetration and tilth in areas of the Cathay soil. A system of conservation tillage that leaves crop residue on the surface and grassed waterways in areas where runoff concentrates help to control water erosion and maintain or improve tilth. Conservation tillage also provides food and cover for resident and migratory wildlife.

In areas where these soils are used for range, the important native forage plants are green needlegrass, western wheatgrass, and needleandthread. Smooth bromegrass, big bluestem, switchgrass, alfalfa, and sweetclover are suitable hay and pasture plants. Water erosion is a hazard, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable plants helps to control water erosion.

The Heimdal soil is suited to nearly all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Cathay soil is suited to many of the climatically adapted species. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings. Individual trees and shrubs growing on the Cathay soil vary in height, density, and vigor, which are affected by restricted root development in the dense subsoil and the reduced amount of available water caused by the salts in the soil.

The land capability classification of the Heimdal soil is IIe, and that of the Cathay soil is IIIe. The productivity index of the unit for spring wheat is 72. The range site of the Heimdal soil is Silty, and that of the Cathay soil is Clayey. The pasture group of the Heimdal soil is Loamy and Silty, and that of the Cathay soil is Clayey Subsoil.

61—Larson-Cathay loams, 0 to 2 percent slopes. These very deep, level and nearly level, sodic soils are on till plains. The somewhat poorly drained Larson soil is in swales. The moderately well drained Cathay soil is on rises. Individual areas range from about 5 to 300 acres in size. They are about 40 to 60 percent Larson soil and 20 to 35 percent Cathay soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the surface layer of the Larson soil is black loam about 9 inches thick. The subsurface layer is very dark grayish brown loam about 2 inches thick. The subsoil is about 22 inches thick. It is black clay loam in the upper part and olive brown, mottled, calcareous loam in the lower part. The substratum to a depth of about 60 inches is olive brown, mottled, calcareous clay loam. In some areas the surface layer is only 2 to 4 inches thick.

Typically, the surface layer of the Cathay soil is black loam about 8 inches thick. The subsoil is about 32 inches thick. It is very dark grayish brown clay loam in the upper part; light brownish gray, mottled, calcareous loam in the next part; and olive brown, mottled, calcareous loam in the lower part. The substratum to a depth of about 60 inches is olive brown, mottled, calcareous loam.

Included with these soils in mapping are small areas of Emrick, Fram, Manfred, and Tonka soils. These included soils make up about 25 percent of the unit. The Emrick, Fram, and Tonka soils do not have a sodic subsoil. The Emrick soils are intermingled with areas of the Cathay soil. The Fram soils are on flats. The poorly drained Manfred and Tonka soils are in depressions.

Permeability is slow in the Larson soil and moderately slow in the Cathay soil. Runoff is slow on both soils. Available water capacity is moderate in the Larson soil and high in the Cathay soil. The dense subsoil restricts the rooting depth of plants. The seasonal high water table is at a depth of 3 to 6 feet in the Larson soil and at a depth of 3 to 5 feet in the Cathay soil. Organic matter content is high in both soils. Tilth is poor.

Most areas are used for cultivated crops. Some areas are used for range, hay, or pasture. These soils

are suited to cultivated crops and range and to grasses and legumes for hay and pasture. The hazards of soil blowing and water erosion are slight. The dense subsoil adversely affects crop production by restricting root penetration and by inhibiting moisture use. The main management concerns in cultivated areas are maintaining or improving tilth and root penetration and controlling erosion. A cropping system that includes deep-rooted legumes improves root penetration and tilth. Tillage when the soil is neither too wet nor too dry helps to maintain tilth in areas of the Larson soil. The surface tends to puddle when wet and to form clods when dry. Timely tillage and additions of organic material improve tilth. A system of conservation tillage that leaves crop residue on the surface helps to control erosion, maintain or improve tilth, and provide food and cover for resident and migratory wildlife.

In areas where these soils are used for range, the important native forage plants are western wheatgrass, green needlegrass and needleandthread. Intermediate wheatgrass, pubescent wheatgrass, western wheatgrass, alfalfa, and sweetclover are suitable hay and pasture plants. The dense, sodic subsoil, which restricts root penetration, and the salts, which reduce the amount of available water, are limitations, especially if the range or pasture is overgrazed. Reestablishing vegetation is difficult in denuded areas. Maintaining an adequate cover of the important or suitable plants helps to prevent denuding. Stock water ponds constructed in areas of these soils sometimes contain salty water.

The Larson soil is suited to only a few of the drought- and salt-tolerant trees and shrubs grown as windbreaks and environmental plantings. Irrigation helps to ensure the survival of seedlings. The Cathay soil is suited to many of the climatically adapted species. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings. Individual trees and shrubs vary in height, density, and vigor, which are affected by restricted root development in the dense subsoil and the reduced amount of available water caused by the salts in the soils.

The land capability classification of the Larson soil is IVs, and that of the Cathay soil is IIIs. The productivity index of the unit for spring wheat is 51. The range site of the Larson soil is Claypan, and that of the Cathay soil is Clayey. The pasture group of the Larson soil is Claypan, and that of the Cathay soil is Clayey Subsoil.

62—Miranda-Larson loams, 0 to 2 percent slopes. These very deep, somewhat poorly drained, level and nearly level, sodic soils are on till plains. The saline Miranda soil is in swales. The Larson soil is on rises. Individual areas range from about 5 to 100 acres in size. They are about 40 to 60 percent Miranda soil and 20 to 40 percent Larson soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the surface layer of the Miranda soil is black loam about 2 inches thick. The subsurface layer is very dark gray silt loam about 2 inches thick. The subsoil is clay loam about 28 inches thick. It is very dark brown in the upper part; very dark grayish brown in the next part; and dark grayish brown, mottled, and calcareous in the lower part. The substratum to a depth of about 60 inches is olive brown, mottled, calcareous clay loam. In some uncultivated areas the surface texture is silt loam. In other areas the soil is poorly drained.

Typically, the surface layer of the Larson soil is black loam about 9 inches thick. The subsurface layer is very dark gray loam about 2 inches thick. The subsoil is about 22 inches thick. It is black clay loam in the upper part and olive brown, mottled, calcareous loam in the lower part. The substratum to a depth of about 60 inches is olive brown, mottled, calcareous clay loam.

Included with these soils in mapping are small areas of Fram, Tonka, and Wyard soils. These included soils make up about 20 percent of the unit. They do not have a sodic subsoil. The Fram soils have an accumulation of lime within a depth of 16 inches. They are on flats. The poorly drained Tonka soils are in depressions. The Wyard soils are intermingled with areas of the Miranda soil.

Permeability is very slow in the Miranda soil and slow in the Larson soil. Runoff is slow on both soils. Available water capacity is moderate. The content of salts in the Miranda soil reduces the amount of water available to plants. The dense subsoil of both soils restricts the rooting depth of plants. The seasonal high water table is at a depth of 2 to 4 feet in the Miranda soil and at a depth of 3 to 6 feet in the Larson soil. Organic matter content is moderate in the Miranda soil and high in the Larson soil.

Most areas are used for range or hay. Some areas are used for cultivated crops. The hazards of soil blowing and water erosion are slight. These soils are best suited to range or wildlife habitat. They generally are unsuited to cultivated crops because of the sodicity, the salinity, and the restricted rooting depth.

In areas where these soils are used as range, the important native forage plants are green needlegrass, western wheatgrass, needleandthread, and blue grama. Western wheatgrass, slender wheatgrass, alfalfa, and sweetclover are suitable hay and pasture plants. The dense, sodic subsoil and the salts that reduce the amount of water available to plants are problems,

especially if the range or pasture is overgrazed. Reestablishing vegetation is difficult in denuded areas. Maintaining an adequate cover of the important or suitable plants helps to prevent denuding. Stock water ponds constructed in areas of these soils frequently contain salty water.

The Miranda soil is generally unsuited to the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Larson soil is suited to only a few of the drought- and salt-tolerant species. Irrigation helps to ensure the survival of seedlings. Individual trees and shrubs growing on the Larson soil vary in height, density, and vigor, which are affected by restricted root development in the dense, sodic subsoil and the reduced amount of available water caused by the salts in the soil.

The land capability classification of the Miranda soil is VIs, and that of the Larson soil is IVs. The productivity index of the unit for spring wheat is 0. Both the range site and the pasture group of the Miranda soil are Thin Claypan, and those of the Larson soil are Claypan.

67—Letcher fine sandy loam, 0 to 3 percent slopes. This very deep, level and nearly level, somewhat poorly drained, sodic soil is on flats or outwash plains. Individual areas range from about 5 to 100 acres in size.

Typically, the surface layer is black fine sandy loam about 9 inches thick. The subsurface layer is very dark brown fine sandy loam about 6 inches thick. The subsoil is fine sandy loam about 21 inches thick. It is very dark grayish brown in the upper part; dark grayish brown, mottled, and calcareous in the next part; and light olive brown, mottled, and calcareous in the lower part. The substratum to a depth of about 60 inches is light olive brown, mottled, calcareous loamy fine sand. In some areas the subsoil is at a depth of 20 to 25 inches. In other areas the substratum is loam.

Included with this soil in mapping are small areas of Embden, Hecla, and Wyndmere soils. These soils make up about 20 percent of the unit. They do not have a sodic subsoil. The moderately well drained Embden and Hecla soils are on rises. The Wyndmere soils are intermingled with areas of the Letcher soil.

Permeability is slow in the upper part of the Letcher soil and moderately rapid in the lower part. Available water capacity is moderate. The dense subsoil restricts the rooting depth of plants. The seasonal high water table is at a depth of 3.5 to 6.0 feet. Organic matter content is moderate. Tilth is fair.

Most areas are used for cultivated crops. Some areas are used for range, hay, or pasture. This soil is poorly suited to cultivated crops. The dense subsoil adversely affects crop production in most years by restricting root penetration and by inhibiting moisture use. The hazard of soil blowing is severe, and the hazard of water erosion is slight. The main management concerns in cultivated areas are maintaining or improving tilth, improving the penetration of roots, and controlling soil blowing. Tillage when the soil is neither too wet nor too dry helps to maintain tilth. The surface tends to puddle when wet and to form clods when dry. Timely tillage and additions of organic material improve tilth. A cropping system that includes deep-rooted legumes improves root penetration and tilth. A system of conservation tillage that leaves crop residue on the surface, field windbreaks, and stripcropping help to control soil blowing. Conservation tillage also provides food and cover for resident and migratory wildlife.

In areas where this soil is used for range, the important native forage plants are blue grama, needleandthread, and western wheatgrass. Tall wheatgrass, intermediate wheatgrass, alfalfa, and sweetclover are suitable hay and pasture plants. The soil blowing is a hazard, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable plants helps to control soil blowing.

This soil is suited to only a few of the drought- and salt-tolerant climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Irrigation helps to ensure the survival of seedlings. Individual trees and shrubs vary in height, density, and vigor, which are affected by restricted root development in the dense, sodic subsoil and the reduced amount of available water caused by the salts in the soil. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification is IVs. The productivity index for spring wheat is 33. The range site is Sandy Claypan. The pasture group is Claypan.

71—Spottswood loam, 0 to 3 percent slopes. This very deep, level and nearly level, moderately well drained soil is on flats on outwash plains and terraces. Individual areas range from about 5 to 300 acres in size.

Typically, the surface layer is black loam about 8 inches thick. The subsoil is loam about 17 inches thick. It is very dark brown in the upper part and dark grayish brown and calcareous in the lower part. The substratum to a depth of about 60 inches is calcareous. It is light olive brown gravelly sand in the upper part; light olive brown fine sand in the next part; and grayish brown fine sand in the lower part. In some areas sand and gravel

is at a depth of 14 to 20 inches. In other areas the subsoil is calcareous.

Included with this soil in mapping are small areas of Sioux and Svea soils. These soils make up about 20 percent of the unit. The excessively drained Sioux soils are on ridges. The Svea soils have a substratum of loam. They are intermingled with areas of the Spottswood soil.

Permeability is moderate in the upper part the Spottswood soil and rapid in the lower part. Runoff is slow. Available water capacity is moderate. The seasonal high water table is at a depth of 3 to 6 feet. Organic matter content is high. Tilth is good.

Most areas are used for cultivated crops. Some areas are used for hay or pasture. This soil is suited to cultivated crops and range and to grasses and legumes for hay and pasture. The hazards of soil blowing and water erosion are slight. The main management concern in cultivated areas is the droughtiness, which reduces crop production during dry periods. A system of conservation tillage that leaves crop residue on the surface helps to control erosion and helps to overcome the droughtiness by trapping snow and thus increasing the moisture supply. It also provides food and cover for resident and migratory wildlife.

In areas where this soil is used for range, the important native forage plants are green needlegrass, western wheatgrass, and needleandthread. Smooth bromegrass, intermediate wheatgrass, big bluestem, indiangrass, alfalfa, and sweetclover are suitable hay and pasture plants. No major hazards affect the use of this soil as range or pasture.

This soil is suited to nearly all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings.

The land capability classification is IIs. The productivity index for spring wheat is 65. The range site is Silty. The pasture group is Loamy and Silty.

72—Divide loam, 0 to 3 percent slopes. This very deep, level and nearly level, somewhat poorly drained, highly calcareous soil is on flats and in drainageways on outwash plains. Individual areas range from about 5 to 400 acres in size.

Typically, the surface soil is black, calcareous loam about 10 inches thick. The subsoil is calcareous loam about 16 inches thick. It is gray in the upper part and light olive brown and mottled in the lower part. The next layer is light olive brown, mottled, calcareous, sandy loam about 4 inches thick. The substratum to a depth of about 60 inches is light olive brown and light brownish gray sand. In some areas the depth to sand is less than 20 inches. In other areas the soil is poorly drained. In some places the subsoil is noncalcareous.

Included with this soil in mapping are small areas of Colvin, Hamerly, and Tonka soils. These soils make up about 10 percent of the unit. The Colvin and Tonka soils are poorly drained. The Colvin soils are in swales. The Tonka soils are in depressions. The Hamerly soils have a substratum of loam. They are intermingled with areas of the Divide soil.

Permeability is moderate in the upper part of the Divide soil and very rapid in the lower part. Runoff is slow. Available water capacity is moderate. The seasonal high water table is at a depth of 2.5 to 5.0 feet. Organic matter content is high. Tilth is good.

Most areas are used for cultivated crops. Some areas are used for hay or pasture. This soil is suited to cultivated crops and range and to grasses and legumes for hay and pasture. The hazard of soil blowing is moderate, and the hazard of water erosion is slight. The main management concern in cultivated areas is controlling soil blowing. A system of conservation tillage that leaves crop residue on the surface, field windbreaks, and stripcropping help to control soil blowing. Conservation tillage also provides food and cover for resident and migratory wildlife.

In areas where this soil is used for range, the important native forage plants are little bluestem, big bluestem, and switchgrass. Tall wheatgrass, smooth bromegrass, indiangrass, switchgrass, intermediate wheatgrass, sweetclover, and alfalfa are suitable hay and pasture plants. The soil blowing is a hazard, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable plants helps to control soil blowing.

This soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification is IIIs. The productivity index for spring wheat is 63. Both the range site and the pasture group are Limy Subirrigated.

77B—Arvilla sandy loam, 0 to 6 percent slopes. This very deep, level to gently sloping, somewhat excessively drained soil is on flats and rises on outwash plains. Individual areas range from about 5 to 300 acres in size.

Typically, the surface soil is black sandy loam about

11 inches thick. The subsoil is dark brown coarse sandy loam about 7 inches thick. The substratum to a depth of about 60 inches is calcareous. It is dark yellowish brown gravelly coarse sand in the upper part, dark brown coarse sand in the next part, and brown sand in the lower part. In some areas the substratum is loamy fine sand. In other areas the gravel in the substratum is mostly shale. In some places the surface texture is loam. In a few places the depth to gravel is only 7 to 14 inches.

Included with this soil in mapping are small areas of Embden, Maddock, and Spottswood soils. These soils make up about 20 percent of the unit. The Embden and Spottswood soils are moderately well drained. They are in swales. The well drained Maddock soils are intermingled with areas of the Arvilla soil.

Permeability is moderately rapid in the upper part of the Arvilla soil and very rapid in the lower part. Runoff is slow. Available water capacity is low. Organic matter content is moderate. Tilth is good.

Most areas are used for cultivated crops, hay, or pasture. Some areas are used for range. This soil is poorly suited to cultivated crops and to grasses and legumes for hay and pasture because of droughtiness and a severe hazard of soil blowing. The hazard of water erosion is slight. The main management concerns in cultivated areas are controlling soil blowing and overcoming the droughtiness. A system of conservation tillage that leaves crop residue on the surface, field windbreaks, and stripcropping help to control erosion. Leaving tall stubble on the surface helps to overcome the droughtiness by trapping snow and thus increasing the moisture supply. Conservation tillage also provides food and cover for resident and migratory wildlife.

In areas where this soil is used for range, the important native forage plants are needleandthread, western wheatgrass, and blue grama. Intermediate wheatgrass, slender wheatgrass, green needlegrass, alfalfa, and sweetclover are suitable hay and pasture plants. The soil blowing is a hazard, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable plants helps to control soil blowing.

This soil is suited to some of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Because the soil is droughty, the trees and shrubs commonly are affected by moisture stress. Irrigation helps to ensure the survival of seedlings. Little benefit is derived from fallowing during the season prior to planting because of the low available water capacity. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification is IIIe. The productivity index for spring wheat is 42. Both the range site and the pasture group are Shallow to Gravel.

78C—Sioux-Arvilla complex, 1 to 9 percent slopes. These very deep, nearly level to moderately sloping soils are on outwash plains. The excessively drained Sioux soil is on knolls and ridges. The somewhat excessively drained Arvilla soil is on flats and rises. Individual areas range from about 5 to 200 acres in size. They are about 50 to 70 percent Sioux soil and 20 to 40 percent Arvilla soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the surface layer of the Sioux soil is black loam about 7 inches thick. The next layer is dark brown, calcareous gravelly loamy sand about 6 inches thick. The substratum to a depth of about 60 inches is dark yellowish brown, calcareous very gravelly sand. In some areas the substratum is sand.

Typically, the surface soil of the Arvilla soil is black sandy loam about 11 inches thick. The subsoil is dark brown coarse sandy loam about 7 inches thick. The substratum to a depth of about 60 inches is calcareous. It is dark yellowish brown gravelly coarse sand in the upper part, dark brown coarse sand in the next part, and brown sand in the lower part. In some areas the surface texture is loam.

Included with these soils in mapping are small areas of Embden, Emrick, and Spottswood soils. These included soils make up about 15 percent of the unit. They are moderately well drained and are in swales.

Permeability is moderately rapid in the upper part of both soils and very rapid in the lower part. Runoff is slow. Available water capacity is low. Organic matter content is moderate.

Most areas are used for range or hay. Some areas are used for cultivated crops. These soils are best suited to range or hay. They are generally unsuited to cultivated crops because of droughtiness and the hazards of soil blowing and water erosion. Establishing a cover of grasses in cultivated areas helps to maintain productivity and control erosion.

In areas where these soils are used as range, the important native forage plants are needleandthread, western wheatgrass, and blue grama. Crested wheatgrass, intermediate wheatgrass, green needlegrass, alfalfa, and sweetclover are suitable hay and pasture plants. The low available water capacity is a problem, especially if the range or pasture is overgrazed. Reestablishing vegetation is difficult in

denuded areas. Maintaining an adequate cover of the important or suitable forage plants at a height that traps snow helps to store water in the soils, control water erosion, and prevent denuding.

The Sioux soil is generally unsuited to the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Arvilla soil is suited to only some of the climatically adapted species. Because the Arvilla soil is droughty, the trees and shrubs commonly are affected by moisture stress. Irrigation helps to ensure the survival of seedlings. Little benefit is derived from fallowing during the season prior to planting because of the low available water capacity of these soils. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification of the Sioux soil is VIs, and that of the Arvilla soil is IVe. The productivity index of the unit for spring wheat is 0. The range site of the Sioux soil is Very Shallow, and that of the Arvilla soil is Shallow to Gravel. The pasture group of the Sioux soil is Very Shallow to Gravel, and that of the Arvilla soil is Shallow to Gravel.

78F—Coe-Heimdal loams, 9 to 35 percent slopes. These very deep soils are on valley side slopes and eskers. The strongly sloping and steep, excessively drained Coe soil is on shoulder slopes and side slopes. The strongly sloping and moderately steep, well drained Heimdal soil is on side slopes. Individual areas range from about 5 to 200 acres in size. They are about 45 to 70 percent Coe soil and 30 to 55 percent Heimdal soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the surface layer of the Coe soil is black loam about 5 inches thick. The next layer is very dark gray, calcareous gravelly loam about 5 inches thick. The substratum to a depth of about 60 inches is calcareous. It is dark grayish brown very gravelly sand in the upper part, grayish brown very gravelly sand in the next part, and grayish brown gravelly coarse sand in the lower part. In some areas the depth to gravel is 14 to 20 inches.

Typically, the surface layer of the Heimdal soil is very dark gray loam about 7 inches thick. The subsoil is loam about 23 inches thick. It is dark brown in the upper part and dark grayish brown and calcareous in the lower part. The substratum to a depth of about 60 inches is olive brown, calcareous loam. In some areas the subsoil is calcareous throughout. In other areas the dark color of the surface layer extends to a depth of more than 16 inches. In some places the substratum is sandy loam.

Included with these soils in mapping are small areas of Fram and La Prairie soils. These included soils make up about 5 percent of the unit. The somewhat poorly drained Fram soils are in swales. The moderately well drained La Prairie soils are in depressions.

Permeability is moderate in the upper part of the Coe soil and very rapid in the lower part. It is moderate in the Heimdal soil. Runoff is rapid on both soils. Available water capacity is very low in the Coe soil and high in the Heimdal soil. Organic matter content is moderate in the Coe soil and high in the Heimdal soil.

Most areas are used for range. These soils are generally unsuited to cultivated crops and pasture and to the trees and shrubs grown as windbreaks and environmental plantings because of the very low available water capacity of the Coe soil, the slope, a moderate hazard of soil blowing, and a severe hazard of water erosion.

In areas where these soils are used as range, the important native forage plants are needleandthread, western wheatgrass, green needlegrass, and blue grama. The very low available water capacity in areas of the Coe soil is a problem, especially if the range is overgrazed. Reestablishing vegetation is difficult in denuded areas. Maintaining an adequate cover of the important plants at a height that traps snow helps to store water in the soils, control water erosion, and prevent denuding. Gullies can form along cattle trails. A planned grazing system that controls the pattern of livestock traffic helps to prevent gullying.

The land capability classification of the Coe soil is VIIs, and that of the Heimdal soil is VIe. The productivity index of the unit for spring wheat is 0. The range site of the Coe soil is Very Shallow, and that of the Heimdal soil is Silty.

80—Towner-Barnes sandy loams, 0 to 3 percent slopes. These very deep, level and nearly level soils are on mantled till plains. The moderately well drained Towner soil is in swales. The well drained Barnes soil is on rises. Individual areas range from about 5 to 100 acres in size. They are about 40 to 65 percent Towner soil and 25 to 45 percent Barnes soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the surface soil of the Towner soil is black sandy loam about 14 inches thick. The subsoil is loamy sand about 20 inches thick. It is very dark grayish brown in the upper part and dark brown in the lower part. The substratum to a depth of about 60 inches is

olive, calcareous loam. In some areas the substratum is loamy fine sand.

Typically, the surface layer of the Barnes soil is black sandy loam about 9 inches thick. The subsoil is loam about 20 inches thick. It is brown in the upper part and light olive brown and calcareous in the lower part. The next layer is light olive brown, calcareous loam about 14 inches thick. The substratum to a depth of about 60 inches also is light olive brown, calcareous loam. In some areas the surface texture is loam. In other areas the dark color of the surface layer extends to a depth of more than 16 inches.

Included with these soils in mapping are small areas of Hamerly, Kratka, Parnell, and Wyndmere soils. These included soils make up about 15 percent of the unit. The somewhat poorly drained Hamerly and Wyndmere soils are on flats. The poorly drained Kratka soils and the very poorly drained Parnell soils are in depressions.

Permeability is rapid in the upper part of the Towner soil and moderately slow in the lower part. It is moderately slow in the Barnes soil. Runoff is slow on both soils. Available water capacity is moderate in the Towner soil and high in the Barnes soil. The seasonal high water table is at a depth of 3 to 6 feet in the Towner soil. Organic matter content is moderate in the Towner soil and high in the Barnes soil. Tilth of both soils is good.

Most areas are used for cultivated crops. Some areas are used for hay or pasture. These soils are suited to cultivated crops and range and to grasses and legumes for hay and pasture. The hazard of soil blowing is severe, and the hazard of water erosion is slight. The main management concern in cultivated areas is controlling soil blowing. A system of conservation tillage that leaves crop residue on the surface, field windbreaks, and stripcropping help to control soil blowing. Conservation tillage also provides food and cover for resident and migratory wildlife.

In areas where these soils are used for range, the important native forage plants are prairie sandreed, green needlegrass, western wheatgrass, and needleandthread. Intermediate wheatgrass, sand bluestem, slender wheatgrass, alfalfa, and sweetclover are suitable hay and pasture plants. The soil blowing is a hazard, especially if the pasture or range is overgrazed. Maintaining an adequate cover of the important or suitable plants helps to control soil blowing.

The Towner soil is suited to many of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Barnes soil is suited to nearly all of the climatically adapted species. The Towner soil is somewhat droughty, and the moisture stress commonly affects the trees and shrubs, particularly during the establishment period. Irrigation helps to ensure the survival of seedlings. Little benefit is derived from fallowing during the season prior to planting because of the moderate available water capacity. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification of the Towner soil is IIIe, and that of the Barnes soil is IIe. The productivity index of the unit for spring wheat is 70. The range site of the Towner soil is Sandy, and that of the Barnes soil is Silty. The pasture group of the Towner soil is Sandy, and that of the Barnes soil is Loamy and Silty.

81—Hecla fine sandy loam, loamy substratum, 0 to 3 percent slopes. This very deep, level and nearly level, moderately well drained soil is on flats on outwash plains and lake plains. Individual areas range from about 5 to 300 acres in size.

Typically, the surface soil is about 23 inches thick. It is black fine sandy loam in the upper part and very dark brown loamy fine sand in the lower part. The next layer is very dark grayish brown, mottled loamy fine sand about 15 inches thick. The substratum to a depth of about 60 inches is mottled and calcareous. It is olive loamy fine sand in the upper part and olive gray clay loam in the lower part. In some areas the substratum is clay loam above a depth of 40 inches. In other areas it is loamy fine sand throughout. In some places it is not mottled. In a few areas the surface texture is loamy fine sand.

Included with this soil in mapping are small areas of Bearden, Lohnes, and Wyndmere soils. These soils make up about 15 percent of the unit. They are intermingled with areas of the Hecla soil. The somewhat poorly drained Bearden and Wyndmere soils are in swales. The well drained Lohnes soils are on rises.

Permeability is rapid in the upper part of the Hecla soil and moderate in the lower part. Runoff is slow. Available water capacity is moderate. The seasonal high water table is at a depth of 3 to 6 feet. Organic matter content is high. Tilth is good.

Most areas are used for cultivated crops. Some areas are used for hay or pasture. This soil is suited to cultivated crops and range and to grasses and legumes for hay and pasture. The hazard of soil blowing is severe, and the hazard of water erosion is slight. The main management concern in cultivated areas is controlling soil blowing. A system of conservation tillage that leaves crop residue on the surface, field windbreaks, and stripcropping help to control soil

blowing. Conservation tillage also provides food and cover for resident and migratory wildlife.

In areas where this soil is used for range, the important native forage plants are needleandthread, prairie sandreed, blue grama, and western wheatgrass. Intermediate wheatgrass, sand bluestem, slender wheatgrass, sweetclover, and alfalfa are suitable hay and pasture plants. The soil blowing is a hazard, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable plants helps to control soil blowing.

This soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification is IIIe. The productivity index for spring wheat is 59. Both the range site and the pasture group are Sandy.

82B—Towner loamy fine sand, 0 to 6 percent slopes. This very deep, level to gently sloping, moderately well drained soil is on flats and rises on mantled till plains. Individual areas range from about 5 to 200 acres in size.

Typically, the surface soil is black loamy fine sand about 14 inches thick. The subsoil is loamy sand about 20 inches thick. It is very dark grayish brown in the upper part and dark brown in the lower part. The substratum to a depth of about 60 inches is calcareous. It is olive loam in the upper part and light brownish gray, mottled silt loam in the lower part. In some areas the subsoil is mottled. In other areas the substratum is loamy fine sand. In some places the surface soil and subsoil are fine sandy loam.

Included with this soil in mapping are small areas of Barnes and Kratka soils. These soils make up about 10 percent of the unit. The well drained Barnes soils are on rises. The poorly drained Kratka soils are in depressions.

Permeability is rapid in the upper part of the Towner soil and moderately slow in the lower part. Runoff is slow. Available water capacity is moderate. The seasonal high water table is at a depth of 3 to 6 feet. Organic matter content is moderately low. Tilth is good.

Most areas are used for cultivated crops, hay, or pasture. A few areas are used for range. This soil is suited to cultivated crops and to grasses and legumes for hay and pasture. The hazard of soil blowing is severe, and the hazard of water erosion is slight. The main management concern in cultivated areas is controlling soil blowing. A system of conservation tillage that leaves crop residue on the surface, field windbreaks, stripcropping, and buffer strips help to control soil blowing. Conservation tillage also provides food and cover for resident and migratory wildlife.

In areas where this soil is used for range, the important native forage plants are prairie sandreed, needleandthread, and sand bluestem. Intermediate wheatgrass, switchgrass, sweetclover, and alfalfa are suitable hay and pasture plants. The soil blowing is a hazard, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable plants helps to control soil blowing.

This soil is suited to many of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Because the soil is somewhat droughty, the trees and shrubs commonly are affected by moisture stress, particularly during the establishment period. Irrigation during the establishment period helps to ensure the survival of seedlings. Little benefit is derived from fallowing during the season prior to planting because of the moderate available water capacity. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification is IIIe. The productivity index for spring wheat is 51. Both the range site and the pasture group are Sands.

84B—Lohnes loamy coarse sand, 0 to 6 percent slopes. This very deep, level to gently sloping, well drained soil is on outwash plains. Individual areas range from about 5 to 400 acres in size.

Typically, the surface soil is black loamy coarse sand about 11 inches thick. The next layer is very dark brown loamy coarse sand about 9 inches thick. The substratum to a depth of about 60 inches is coarse sand. It is dark yellowish brown in the upper part and dark brown, mottled, and calcareous in the lower part. In some areas the soil is loamy fine sand throughout. In other areas the surface soil and subsoil are sandy loam.

Included with this soil in mapping are small areas of the moderately well drained Embden soils. These soils make up about 10 percent of the unit. They are in swales.

Permeability is rapid in the Lohnes soil, and runoff is slow. Available water capacity is low. Organic matter content is moderately low. Tilth is good.

Most areas are used for cultivated crops, hay, or

pasture. Some areas are used for range. This soil is poorly suited to cultivated crops because of a severe hazard of soil blowing and the low available water capacity. It is best suited to hay, pasture, or range. The hazard of soil blowing is severe, and the hazard of water erosion is slight. Droughtiness, a result of the low available water capacity, reduces crop growth. The main management concerns in cultivated areas are controlling soil blowing and overcoming the droughtiness. A system of conservation tillage that leaves crop residue on the surface, field windbreaks, and stripcropping help to control soil blowing. Leaving tall stubble on the surface helps to overcome the droughtiness. Conservation tillage also provides food and cover for resident and migratory wildlife.

In areas where this soil is used for range, the important native forage plants are prairie sandreed, needleandthread, and sand bluestem. Intermediate wheatgrass, switchgrass, sweetclover, and alfalfa are suitable hay and pasture plants. The soil blowing is a hazard, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable plants helps to control soil blowing.

This soil is suited to a few of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Because the soil is droughty, the trees and shrubs commonly are affected by moisture stress. Irrigation helps to ensure the survival of seedlings. Little benefit is derived from fallowing during the season prior to planting because of the low available water capacity. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification is IVe. The productivity index for spring wheat is 37. The range site is Sands. The pasture group is Shallow to Gravel.

86B—Maddock loamy fine sand, 0 to 6 percent slopes. This very deep, level to gently sloping, well drained soil is on flats and rises on outwash plains and lake plains. Individual areas range from about 5 to 700 acres in size.

Typically, the surface soil is black loamy fine sand about 12 inches thick. The substratum to a depth of about 60 inches is fine sand. It is dark yellowish brown in the upper part and light olive brown in the lower part. In some areas the substratum is loam. In other areas it is mottled. In some places the soil is loamy coarse sand throughout.

Included with this soil in mapping are small areas of the somewhat poorly drained Wyndmere soils. These soils make up about 5 percent of the unit. They are in swales. Also included are small areas of poorly drained soils in depressions.

Permeability is rapid in the Maddock soil, and runoff is slow. Available water capacity is moderate. Organic matter content is moderately low. Tilth is good.

Most areas are used for cultivated crops, hay, or pasture. A few areas are used for range. This soil is suited to cultivated crops and range and to grasses and legumes for hay and pasture. The hazard of soil blowing is severe, and the hazard of water erosion is slight. The main management concerns in cultivated areas are controlling soil blowing and overcoming droughtiness. The droughtiness, a result of the moderate available water capacity, reduces crop growth. A system of conservation tillage that leaves crop residue on the surface, field windbreaks, stripcropping, and buffer strips help to control soil blowing. Leaving tall stubble on the surface helps to overcome the droughtiness by trapping snow and thus increasing the moisture supply. Conservation tillage also provides food and cover for resident and migratory wildlife.

In areas where this soil is used for range, the important native forage plants are prairie sandreed, needleandthread, and sand bluestem. Intermediate wheatgrass, switchgrass, sweetclover, and alfalfa are suitable hay and pasture plants. The soil blowing is a hazard, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable plants helps to control soil blowing.

This soil is suited to many of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Because the soil is somewhat droughty, the trees and shrubs commonly are affected by moisture stress, particularly during the establishment period. Irrigation helps to ensure the survival of seedlings. Little benefit is derived from fallowing during the season prior to planting because of the moderate available water capacity. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification is IVe. The productivity index for spring wheat is 42. Both the range site and the pasture group are Sands.

89D—Maddock-Barnes-Towner complex, 6 to 15 percent slopes. These very deep soils are on mantled till plains and moraines. The well drained, moderately

sloping and strongly sloping Maddock soil is on side slopes and foot slopes. The well drained, moderately sloping and strongly sloping Barnes soil is on side slopes and summits. The moderately well drained, moderately sloping Towner soil is in swales. Individual areas range from about 5 to 200 acres in size. They are about 35 to 55 percent Maddock soil, 25 to 45 percent Barnes soil, and 10 to 25 percent Towner soil. The three soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the surface soil of the Maddock soil is black loamy fine sand about 12 inches thick. The substratum to a depth of about 60 inches is fine sand. It is dark yellowish brown in the upper part and light olive brown in the lower part. In some areas the substratum is mottled. In other areas the dark surface layer is less than 6 inches thick. In some places the surface soil and subsoil are fine sandy loam.

Typically, the surface layer of the Barnes soil is black loam about 9 inches thick. The subsoil is loam about 20 inches thick. It is brown in the upper part and light olive brown and calcareous in the lower part. The next layer is light olive brown, calcareous loam about 14 inches thick. The substratum to a depth of about 60 inches also is light olive brown, calcareous loam. In some areas the subsoil is calcareous throughout.

Typically, the surface soil of the Towner soil is black loamy fine sand about 14 inches thick. The subsoil is loamy sand about 20 inches thick. It is very dark grayish brown in the upper part and dark brown in the lower part. The substratum to a depth of about 60 inches is olive, calcareous loam. In some areas the surface soil and subsoil are fine sandy loam.

Included with these soils in mapping are small areas of excessively drained Sioux soils on ridges. These included soils make up about 10 percent of the unit. Also included are small areas of stony soils along Baldhill Creek.

Permeability is rapid in the Maddock soil and moderately slow in the Barnes soil. It is rapid in the upper part of the Towner soil and moderately slow in the lower part. Runoff is medium on the Maddock and Towner soils and rapid on the Barnes soil. Available water capacity is moderate in the Maddock and Towner soils and high in the Barnes soil. The seasonal high water table is at a depth of 3 to 6 feet in the Towner soil. Organic matter content is moderately low in the Maddock and Towner soils and high in the Barnes soil.

Most areas are used for hay, pasture, or range. Some areas are used for cultivated crops. The hazard of soil blowing is severe on the Maddock and Towner soils and slight on the Barnes soil. The hazard of water erosion is moderate on the Maddock and Towner soils and severe on the Barnes soil. These soils are best suited to range, hay, or pasture. They are generally unsuited to cultivated crops because of droughtiness in areas of the Maddock soil, the severe hazard of soil blowing in areas of the Maddock and Towner soils, the hazard of water erosion on all three soils, and the slope. Establishing a cover of grasses in cultivated areas helps to maintain productivity and control erosion.

In areas where these soils are used as range, the important native forage plants are prairie sandreed, sand bluestem, needleandthread, and western wheatgrass. Intermediate wheatgrass, pubescent wheatgrass, switchgrass, western wheatgrass, alfalfa, and sweetclover are suitable hay and pasture plants. Water erosion and soil blowing are hazards, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable plants helps to control erosion.

The Maddock and Towner soils are generally unsuited to the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Trees and shrubs can be grown for esthetic purposes or to enhance wildlife habitat if special management, such as hand or scalp planting, is applied. The Barnes soil is suited to nearly all of climatically adapted species. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings.

The land capability classification of the Maddock and Towner soils is VIe, and that of the Barnes soil is IVe. The productivity index of the unit for spring wheat is 0. The range site of the Maddock and Towner soils is Sands, and that of the Barnes soil is Silty. The pasture group of the Maddock and Towner soils is Sands, and that of the Barnes soil is Loamy and Silty.

90—Ulen-Hecla fine sandy loams, 0 to 2 percent slopes. These very deep, level and nearly level soils are on outwash plains and lake plains. The somewhat poorly drained, highly calcareous Ulen soil is on flats and in swales. The moderately well drained Hecla soil is on flats and rises. Individual areas range from about 5 to 100 acres in size. They are about 35 to 60 percent Ulen soil and 35 to 55 percent Hecla soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Ulen soil has a surface soil about 13 inches thick. It is black, calcareous fine sandy loam in the upper part and very dark grayish brown, calcareous loamy fine sand in the lower part. The subsoil is calcareous loamy fine sand about 29 inches thick. It is dark grayish brown and mottled in the upper part and grayish brown in the lower part. The substratum to a depth of about 60 inches is light olive brown, mottled,

calcareous fine sand. In some areas the surface texture is loamy fine sand. In other areas the subsoil is fine sandy loam.

Typically, the Hecla soil has a surface soil about 23 inches thick. It is black fine sandy loam in the upper part and very dark brown loamy fine sand in the lower part. The next layer is very dark grayish brown, mottled loamy fine sand about 15 inches thick. The substratum to a depth of about 60 inches is olive, mottled, calcareous loamy fine sand. In some areas the soil has a substratum of loam at a depth of 30 to 60 inches.

Included with these soils in mapping are small areas of Glyndon soils. These included soils make up about 10 percent of the unit. They have a subsoil and substratum of silt loam. They are intermingled with areas of the Ulen soil.

Permeability is rapid in the Ulen and Hecla soils. Runoff is slow. Available water capacity is low in the Ulen soil and moderate in the Hecla soil. The seasonal high water table is at a depth of 2.5 to 6.0 feet in the Ulen soil and at a depth of 3.0 to 6.0 feet in the Hecla soil. Organic matter content is moderate in both soils. Tilth is good.

Most areas are used for cultivated crops. Some areas are used for hay or pasture. These soils are suited to cultivated crops and range and to grasses and legumes for hay and pasture. The hazard of soil blowing is severe, and the hazard of water erosion is slight. The main management concern in cultivated areas is controlling soil blowing. A system of conservation tillage that leaves crop residue on the surface, field windbreaks, and stripcropping help to control soil blowing. Conservation tillage also provides food and cover for resident and migratory wildlife.

In areas where these soils are used for range, the important native forage plants are switchgrass, big bluestem, little bluestem, prairie sandreed, and needleandthread. Tall wheatgrass, indiangrass, smooth bromegrass, little bluestem, intermediate wheatgrass, sweetclover, and alfalfa are suitable hay and pasture plants. The soil blowing is a hazard, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable plants helps to control soil blowing.

These soils are suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification of both soils is IIIe. The productivity index of the unit for spring wheat is 59. Both the range site and the pasture group of the Ulen soil are Limy Subirrigated, and those of the Hecla soil are Sandy.

91B—Swenoda fine sandy loam, 0 to 6 percent slopes. This very deep, level to undulating, moderately well drained soil is on flats and rises on mantled till plains and lake plains. Individual areas range from about 5 to 400 acres in size.

Typically, the surface soil is black fine sandy loam about 11 inches thick. The subsoil is fine sandy loam about 21 inches thick. It is very dark grayish brown in the upper part and grayish brown and calcareous in the lower part. The substratum to a depth of about 60 inches is light olive brown, mottled, and calcareous. It is loamy fine sand in the upper part and silty clay loam in the lower part. In some areas the dark color of the surface soil and that of the upper part of the subsoil extends to a depth of only 8 to 16 inches. In other areas the substratum is fine sandy loam. In some places the surface soil is loam.

Included with this soil in mapping are small areas of Barnes, Fram, Kratka, and Towner soils. These soils make up about 15 percent of the unit. The well drained Barnes soils and the somewhat poorly drained Fram soils are in swales. The poorly drained Kratka soils are in depressions. The Towner soils have a subsoil of loamy sand. They are intermingled with areas of the Swenoda soil.

Permeability is moderately rapid in the upper part of the Swenoda soil and moderately slow in the lower part. Runoff is slow. Available water capacity is high. The seasonal high water table is at a depth of 2.5 to 4.0 feet. Organic matter content is high. Tilth is good.

Most areas are used for cultivated crops. This soil is suited to cultivated crops and range and to grasses and legumes for hay and pasture. The hazard of soil blowing is severe, and the hazard of water erosion is slight. The main management concern in cultivated areas is controlling soil blowing. A system of conservation tillage that leaves crop residue on the surface, field windbreaks, and stripcropping help to control soil blowing. Conservation tillage also provides food and cover for resident and migratory wildlife.

In areas where this soil is used for range, the important native forage plants are needleandthread, prairie sandreed, blue grama, and western wheatgrass. Intermediate wheatgrass, slender wheatgrass, green needlegrass, sweetclover, and alfalfa are suitable hay and pasture plants. The soil blowing is a hazard, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable plants helps to control soil blowing.

Figure 9.—An area of Colvin and La Prairie soils, channeled.

This soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification is IIIe. The productivity index for spring wheat is 71. Both the range site and the pasture group are Sandy.

95—Colvin and La Prairie soils, channeled. These very deep, level soils are on flats on flood plains. The poorly drained, highly calcareous Colvin soil is frequently flooded. The moderately well drained La Prairie soil is occasionally flooded. Individual areas range from about 5 to 200 acres in size. They are dissected into small, irregularly shaped areas by meandering channels that are too deep or too wet to cross with farm machinery (fig. 9). Any one area can consist of all Colvin soil, all La Prairie soil, or a combination of both soils.

Typically, the surface layer of the Colvin soil is black, calcareous silt loam about 7 inches thick. The subsoil is about 29 inches thick. It is dark gray, calcareous silty clay loam in the upper part; grayish brown, calcareous silty clay loam in the next part; and light gray and olive, mottled, calcareous silt loam in the lower part. The substratum to a depth of about 60 inches is gray, mottled silt loam.

Typically, the surface soil of the La Prairie soil is loam about 24 inches thick. It is black in the upper part and very dark gray in the lower part. The subsoil is loam about 26 inches thick. It is very dark grayish brown in the upper part and dark brown and calcareous in the lower part. The substratum to a depth of about 60 inches is light olive brown, calcareous loam. In some areas the soil has a substratum of sand below a depth of 40 inches.

Included with these soils in mapping are small areas

of very poorly drained Southam soils. These included soils make up about 15 percent of the unit. They are in oxbows. Also included are small areas of poorly drained soils that have a gravelly substratum.

Permeability is moderately slow in the Colvin soil and moderate in the La Prairie soil. Runoff is slow on both soils. Available water capacity is high. The seasonal high water table is within a depth of 1.0 foot in the Colvin soil and at a depth of 3.5 to 6.0 feet in the La Prairie soil. Organic matter content is high in both soils.

Most areas are used for range or wildlife habitat. A few areas are used for cultivated crops. Because of the meandering channels, these soils are generally unsuited to cultivated crops and to the machine-planted trees and shrubs grown as windbreaks and environmental plantings. Tillable areas are generally small and irregular in shape. Hand-planted trees and shrubs can be grown. The main concern in managing wildlife habitat is maintaining the diversity of plants.

In areas where these soils are used as range, the important native forage plants are big bluestem, little bluestem, switchgrass, green needlegrass, and western wheatgrass. Scouring is a hazard, especially during flooding. Maintaining an adequate cover of the important forage plants helps to control the scouring.

The land capability classification of both soils is Vlw. The productivity index of the unit for spring wheat is 0. The range site of the Colvin soil is Subirrigated, and that of the La Prairie soil is Overflow. The pasture group of the Colvin soil is Wet, and that of the La Prairie soil is Overflow and Run-on.

96—La Prairie loam. This very deep, level, moderately well drained soil is on flats on flood plains. It is subject to rare flooding. Individual areas range from about 5 to 500 acres in size.

Typically, the surface soil is loam about 24 inches thick. It is black in the upper part and very dark gray in the lower part. The subsoil is loam about 26 inches thick. It is very dark grayish brown in the upper part and dark brown and calcareous in the lower part. The substratum to a depth of about 60 inches is light olive brown, calcareous loam. In some areas the soil has a substratum of sand below a depth of 40 inches.

Included with this soil in mapping are small areas of Embden and Spottswood soils. These soils make up about 15 percent of the unit. They have a substratum of fine sand. They are intermingled with areas of the La Prairie soil.

Permeability is moderate in the La Prairie soil, and runoff is slow. Available water capacity is high. Organic matter content also is high. Tilth is good.

Most areas are used for cultivated crops or range. This soil is suited to cultivated crops and to grasses and legumes for hay and pasture. The hazards of soil blowing and water erosion are slight. The main management concerns in cultivated areas are controlling erosion and maintaining tilth. A system of conservation tillage that leaves crop residue on the surface helps to control erosion, maintain tilth, and provide food and cover for resident and migratory wildlife.

In areas where this soil is used for range, the important native forage plants are western wheatgrass, needleandthread, and green needlegrass. Smooth bromegrass, intermediate wheatgrass, alfalfa, and sweetclover are suitable hay and pasture plants. No major hazards affect the use of this soil as range or pasture.

This soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. It has no critical limitations. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings.

The land capability classification is IIc. The productivity index for spring wheat is 96. The range site is Silty. The pasture group is Loamy and Silty.

99—Pits, sand and gravel. This map unit is in areas from which the soil has been removed and the underlying sand and gravel mined. Many of the areas are abandoned, and the acreage is idle land. Most of the areas support little or no vegetation. They range from about 3 to 80 acres in size.

This unit generally is unsuited to agricultural uses unless the areas are leveled, topdressed with suitable topsoil, and otherwise reclaimed. In unreclaimed areas planting climatically adapted trees can enhance wildlife habitat or increase the esthetic value. The suitability for individual species of trees and shrubs varies from pit to pit.

No land capability classification, range site, or pasture group is assigned. The productivity index for spring wheat is 0.

102—Kratka fine sandy loam. This very deep, level, poorly drained soil is in depressions on lake plains and mantled till plains. Individual areas range from about 3 to 70 acres in size.

Typically, the surface layer is black fine sandy loam about 8 inches thick. The subsoil is about 37 inches thick. It is grayish brown, mottled fine sand in the upper part; dark grayish brown, mottled loamy fine sand in the next part; and light gray, calcareous silt loam in the lower part. The substratum to a depth of about 60 inches is olive gray, mottled, calcareous silty clay loam.

In some areas the soil is calcareous throughout the profile.

Included with this soil in mapping are small areas of Hecla, Vallers, and Wyndmere soils. These soils make up about 15 percent of the unit. The moderately well drained Hecla soils and the somewhat poorly drained Wyndmere soils are on rises. The Vallers soils have a surface layer and subsoil of loam. They are on flats.

Permeability is moderately rapid in the upper part of the Kratka soil and moderately slow in the lower part. Runoff is very slow. Available water capacity is moderate. The seasonal high water table is at a depth of 0.5 foot to 3.0 feet. Organic matter content is moderate. Tilth is good.

Most areas are used for cultivated crops. Some areas are used for hay or pasture. This soil is suited to cultivated crops and range and to grasses and legumes for hay and pasture. The hazard of soil blowing is severe, and the hazard of water erosion is slight. The main management concerns in cultivated areas are the excessive wetness and soil blowing. A drainage system increases the suitability of the soil for cultivated crops; however, locating suitable drainage outlets is difficult. In undrained areas crops are harvested in only about 5 to 7 years out of 10. In areas where the soil is drained and cultivated, a system of conservation tillage that leaves crop residue on the surface, field windbreaks, and stripcropping help to control soil blowing. Conservation tillage also provides food and cover for resident and migratory wildlife.

In areas where this soil is used for range, the important native forage plants are big bluestem, switchgrass, and prairie cordgrass. Alsike clover, creeping foxtail, reed canarygrass, big bluestem, and switchgrass are suitable hay and pasture plants. The soil blowing is a hazard, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable plants helps to control soil blowing.

If drained, this soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Undrained areas generally are unsuited to the climatically adapted species. The wetness is a critical limitation affecting survival, growth, and vigor. The grasses and weeds growing on this soil are abundant and persistent. Eliminating this ground cover before the trees and shrubs are planted and then controlling the regrowth of this cover improve the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification is IIIw. The productivity index for spring wheat is 30 to 59, depending on the degree of drainage. The range site is Subirrigated. The pasture group is Wet.

Prime Farmland

Prime farmland is one of several kinds of important farmland defined by the U.S. Department of Agriculture. It is of major importance in meeting the Nation's short- and long-range needs for food and fiber. Because the supply of high-quality farmland is limited, the U.S. Department of Agriculture recognizes that responsible levels of government, as well as individuals, should encourage and facilitate the wise use of our Nation's prime farmland.

Prime farmland, as defined by the U.S. Department of Agriculture, is the land that is best suited to food, feed, forage, fiber, and oilseed crops. It may be cultivated land, pasture, woodland, or other land, but it is not urban or built-up land or water areas. It either is used for food or fiber crops or is available for those crops. The soil qualities, growing season, and moisture supply are those needed for a well managed soil to produce a sustained high yield of crops in an economic manner. Prime farmland produces the highest yields with minimal expenditure of energy and economic resources, and farming it results in the least damage to the environment.

Prime farmland has an adequate and dependable supply of moisture from precipitation or irrigation. The temperature and growing season are favorable. The level of acidity or alkalinity is acceptable. Prime farmland has few or no rocks and is permeable to water and air. It is not excessively erodible or saturated with water for long periods and is not frequently flooded during the growing season. The slope ranges mainly from 0 to 6 percent. More detailed information about the criteria for prime farmland is available at the local office of the Soil Conservation Service.

About 251,000 acres in the survey area, or slightly more than 60 percent of the total acreage, meets the soil requirements for prime farmland.

The map units in the survey area that are considered prime farmland are listed at the end of this section. This list does not constitute a recommendation for a particular land use. The extent of each listed map unit is shown in table 4. The location is shown on the detailed soil maps at the back of this publication. The soil qualities that affect use and management are described under the heading "Detailed Soil Map Units."

Some soils that have a seasonal high water table qualify as prime farmland only in areas where this limitation has been overcome by drainage measures. The need for these measures is indicated after the map unit name in this section. Onsite evaluation is needed to

determine whether or not this limitation has been overcome by corrective measures.

The map units that meet the requirements for prime farmland are:

3	Tonka silt loam (where drained)
21	Svea loam, 0 to 2 percent slopes
22	Svea-Barnes loams, 0 to 3 percent slopes
23	Hamerly-Wyard loams, 0 to 3 percent slopes (where drained)
26B	Barnes-Svea loams, 3 to 6 percent slopes
27B	Barnes-Buse loams, 3 to 6 percent slopes
33	Fram-Wyard loams, 0 to 3 percent slopes (where drained)
36	Heimdal-Emrick loams, 0 to 3 percent slopes
36B	Heimdal-Emrick loams, 3 to 6 percent slopes
37B	Heimdal-Esmond loams, 3 to 6 percent slopes
41B	Embden fine sandy loam, 0 to 6 percent slopes
42	Wyndmere-Arveson complex, loamy substratum, 0 to 3 percent slopes (where drained)
51	Bearden silty clay loam, sandy substratum
52	Glyndon loam, 0 to 2 percent slopes
71	Spottswood loam, 0 to 3 percent slopes
72	Divide loam, 0 to 3 percent slopes
91B	Swenoda fine sandy loam, 0 to 6 percent slopes
96	La Prairie loam
102	Kratka fine sandy loam (where drained)

Use and Management of the Soils

This soil survey is an inventory and evaluation of the soils in the survey area. It can be used to adjust land uses to the limitations and potentials of natural resources and the environment. Also, it can help to prevent soil-related failures in land uses.

In preparing a soil survey, soil scientists, conservationists, engineers, and others collect extensive field data about the nature and behavioral characteristics of the soils. They collect data on erosion, droughtiness, flooding, and other factors that affect various soil uses and management. Field experience and collected data on soil properties and performance are used as a basis in predicting soil behavior.

Information in this section can be used to plan the use and management of soils for crops and pasture; as rangeland and woodland; as sites for buildings, sanitary facilities, highways and other transportation systems, and parks and other recreational facilities; and for wildlife habitat. It can be used to identify the potentials and limitations of each soil for specific land uses and to help prevent construction failures caused by unfavorable soil properties.

Planners and others using soil survey information can evaluate the effect of specific land uses on productivity and on the environment in all or part of the survey area. The survey can help planners to maintain or create a land use pattern in harmony with the natural soil.

Contractors can use this survey to locate sources of sand and gravel, roadfill, and topsoil. They can use it to identify areas where bedrock, wetness, or very firm soil layers can cause difficulty in excavation.

Health officials, highway officials, engineers, and others may also find this survey useful. The survey can help them plan the safe disposal of wastes and locate sites for pavements, sidewalks, campgrounds, playgrounds, lawns, and trees and shrubs.

Crops and Pasture

Prepared by Douglas A. Gasseling, agronomist, and Lucky L. Huether, district conservationist, Soil Conservation Service.

General management needed for crops and pasture is suggested in this section. The crops or pasture plants best suited to the soils, including some not commonly grown in the survey area, are identified; the system of land capability classification used by the Soil Conservation Service is explained; and the estimated yields of the main crops and hay and pasture plants are listed for each soil.

Planners of management systems for individual fields or farms should consider the detailed information given in the description of each soil under the heading "Detailed Soil Map Units." Specific information can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

At the end of each map unit description, the soil has been assigned to a pasture suitability group. These groups are based primarily on the suitability of the soil for certain pasture species, management needs, and potential productivity. Detailed interpretations for each pasture group in the county are provided in the "Technical Guide," which is available in the local office of the Soil Conservation Service.

About 83 percent of Foster County is cultivated. In 1990, about 176,000 acres was used for close-grown crops, 72,500 acres for row crops, and 25,000 acres for forage crops *(17)*. During the period 1985 to 1989, the acreage used for close-grown crops averaged 153,400 acres per year. The acreage of summer fallow was 70,000 acres in 1987, 50,000 acres in 1988, and 30,000 acres in 1989 *(16)*. The acreage used for sunflowers is decreasing. It averaged 71,900 acres per year during the period 1984-88, but was 70,000 acres in 1989 and only 65,000 acres in 1990. The acreage used for corn and forage has been stable in recent years. In 1990, the acreages of the principal close-grown crops were as follows—spring wheat, 140,000 acres; durum wheat, 9,000 acres; winter wheat, 18,000 acres; barley, 15,000 acres; oats, 8,000 acres; rye, 1,000 acres; and flax, 1,200 acres. The main row crops were sunflowers and corn. Sunflowers were grown on 65,000 acres and corn on 7,500 acres. Alfalfa was grown on 11,000 acres and other hay crops on 14,000 acres. Small acreages were planted to mustard, buckwheat, sorghum, millet, or safflower. In 1990, approximately 24,300 acres was enrolled in the Conservation Reserve Program.

The potential of the soils in Foster County for

increased production of food and fiber is good. This production is steadily increasing as the latest crop production technology is applied. This soil survey can facilitate the application of this technology.

The soils and climate of the county are suited to most of the crops that are commonly grown in the survey area. The crops that are not commonly grown but are suitable include lentils, potatoes, and rapeseed.

The principal management measures that help to ensure continuing productivity are those that control soil blowing and water erosion, maintain or improve fertility and tilth, and result in proper utilization of soil moisture.

Water erosion and soil blowing reduce the productivity of the soils. If the surface layer is lost, most of the available plant nutrients also are lost. As a result, applications of fertilizer are needed to maintain adequate crop production.

Of equal concern is the loss of organic matter through erosion. Soil structure, water infiltration, available water capacity, and tilth are all negatively affected by this loss. As organic matter is lost and the subsoil is exposed and tilled, the remaining soil becomes increasingly susceptible to both soil blowing and water erosion.

Soil blowing is a hazard on some of the soils in Foster County. It is a severe hazard on the coarse textured and moderately coarse textured soils, including Arvilla, Barnes, Embden, Hecla, Kratka, Letcher, Lohnes, Maddock, Minnewaukan, Swenoda, Towner, and Ulen soils.

Arveson, Buse, Colvin, Divide, Esmond, Fram, Glyndon, Hamerly, Ulen, and Vallers soils have a relatively high content of lime and are susceptible to soil blowing in the spring if they have been bare throughout the winter. Because of freezing and thawing, soil structure breaks down, resulting in aggregates that are susceptible to movement. Nearly all soils can be damaged by soil blowing if they are bare.

Water erosion is a severe hazard on moderately sloping and steeper soils, such as Barnes, Buse, Esmond, Heimdal, Maddock, and Svea soils. It also is a severe hazard on the more gently sloping soils having long slopes. The hazard is greatest when the surface is bare.

Conservation practices that control both soil blowing and water erosion are those that maintain a protective plant cover. Examples are conservation tillage systems that keep a protective amount of crop residue on the surface. Applications of herbicide can help to eliminate the need for summer fallow tillage. Cover crops also are effective in controlling both soil blowing and water erosion. Field windbreaks, annual wind barriers, and stripcropping help to control soil blowing. A cropping sequence that includes grasses and legumes, grassed waterways, diversions, terraces, contour farming, and field stripcropping across the slope help to control water erosion. A management system that includes several measures is the best means of protecting the soil. For example, conservation tillage can control soil blowing during years when the amount of crop residue is adequate, but windbreaks are needed during years when the amount of residue is low.

Moisture at planting time is critical to the success of the crop during the growing season. In years when the amount of available soil moisture is low at planting time, the success of cropping is greatly reduced. Measures that reduce evaporation and runoff rates, increase the rate of water infiltration, and control weeds conserve moisture. Examples are stubble mulching; a system of conservation tillage, such as mulch tillage or no-till farming; stripcropping; cover crops; crop residue management; standing stubble and annual wind barriers, which trap snow; and applications of fertilizer. When fallow is used to carry moisture over to the next season, a cover of crop residue is essential during winter to guard against moisture loss and erosion. Weed control helps to prevent depletion of the moisture supply.

Measures that improve fertility are needed on many soils. Examples are applications of commercial fertilizer, green manure crops, inclusion of legumes in the cropping sequence, and applications of barnyard manure.

Proper management of soils includes measures that maintain good tilth. These measures are especially needed on the soils that have a surface layer of silty clay loam, clay loam, or silty clay. Arveson soils are an example. Measures that maintain the content of organic matter are very important if good tilth is to be maintained. The traditional practice of clean-tilled summer fallow contributes to the loss of organic matter because it increases the susceptibility to erosion.

Pasture Groups

The following paragraphs describe the pasture groups in Foster County. They specify the production potential under improved management and representative adapted forage species for each group. The names of the groups are Clayey Subsoil, Claypan, Limy Subirrigated, Loamy and Silty, Overflow and Run-on, Saline, Sands, Sandy, Shallow to Gravel, Sodic and Saline, Thin Claypan, Thin Upland, Very Shallow to Gravel, and Wet.

Clayey Subsoil pasture group. This group of soils has a subsoil that somewhat restricts root penetration. The production potential is moderately high. Suitable forage species include smooth bromegrass, Russian

wildrye, western wheatgrass, green needlegrass, switchgrass, alfalfa, and sweetclover.

Claypan pasture group. This group of soils has a dense subsoil that restricts root penetration. The production potential is low. Suitable forage species include western wheatgrass, tall wheatgrass, intermediate wheatgrass, pubescent wheatgrass, slender wheatgrass, alfalfa, and sweetclover.

Limy Subirrigated pasture group. This group of soils has a highly calcareous subsoil. The production potential is high. Suitable forage species include big bluestem, indiangrass, switchgrass, little bluestem, smooth bromegrass, intermediate wheatgrass, pubescent wheatgrass, tall wheatgrass, slender wheatgrass, sweetclover, and birdsfoot trefoil.

Loamy and Silty pasture group. This group of soils has a subsoil that is permeable to roots. The soils have a relatively high content of silt and clay and a low content of sand. The production potential is high. Suitable forage species include smooth bromegrass, meadow bromegrass, intermediate wheatgrass, pubescent wheatgrass, switchgrass, indiangrass, big bluestem, slender wheatgrass, streambank wheatgrass, alfalfa, and sweetclover.

Overflow and Run-On pasture group. This group of soils is in areas that receive additional moisture because of stream overflow or runoff from the surrounding areas. The production potential is high. Suitable forage species include smooth bromegrass, meadow bromegrass, intermediate wheatgrass, pubescent wheatgrass, Russian wildrye, altai wildrye, western wheatgrass, thickspike wheatgrass, green needlegrass, slender wheatgrass, big bluestem, indiangrass, switchgrass, alfalfa, and sweetclover.

Saline pasture group. This group of soils has enough salts to interfere with plant growth. Wetness is a problem. Severely affected areas can be improved, particularly during the establishment period, by mulch, which reduces the extent of surface drying and improves seedling emergence. The better suited forage species include tall wheatgrass, slender wheatgrass, western wheatgrass, beardless wildrye, alkali sacaton, alsike clover, and sweetclover.

Sands pasture group. This group of soils has a subsoil that is permeable to roots. The soils have a relatively high content of sand and a low content of silt and clay. The production potential is moderately high. Suitable forage species include sand bluestem, prairie sandreed, switchgrass, green needlegrass, intermediate wheatgrass, pubescent wheatgrass, and alfalfa.

Sandy pasture group. This group of soils has a subsoil that is permeable to roots. The soils have a relatively high content of sand and a moderate content of silt and clay. The production potential is high. Suitable forage species include green needlegrass, slender wheatgrass, western wheatgrass, intermediate wheatgrass, pubescent wheatgrass, prairie sandreed, sand bluestem, switchgrass, alfalfa, and sweetclover.

Shallow to Gravel pasture group. This group of soils has a substratum that has a relatively high content of sand or sand and gravel at a depth of about 14 to 25 inches. The production potential is moderate. Drought-tolerant forage species grow best. Suitable species include crested wheatgrass, green needlegrass, western wheatgrass, slender wheatgrass, intermediate wheatgrass, pubescent wheatgrass, and alfalfa.

Sodic and Saline pasture group. This group of soils has a subsoil that restricts root penetration and contains enough salts to interfere with plant growth. The production potential is moderately low. Surface mulch reduces the extent of surface drying and improves seedling emergence. Suitable forage species include tall wheatgrass, western wheatgrass, slender wheatgrass, Russian wildrye, beardless wildrye, switchgrass, alkali sacaton, alsike clover, and sweetclover.

Thin Claypan pasture group. This group of soils has a very dense subsoil that severely restricts root penetration and has enough salts to interfere with plant growth. The production potential is very low. Suitable forage species include western wheatgrass, slender wheatgrass, and alfalfa.

Thin Upland pasture group. This group of soils is in areas where runoff occurs. The soils have a highly calcareous subsoil. Soil blowing and water erosion are management concerns, particularly during the establishment of seedlings. The production potential is moderate. Suitable forage species include smooth bromegrass, intermediate wheatgrass, pubescent wheatgrass, western wheatgrass, green needlegrass, little bluestem, prairie sandreed, sideoats grama, sweetclover, and alfalfa.

Very Shallow to Gravel pasture group. This group of soils has a substratum that has a high content of sand or sand and gravel within a depth of 14 inches. The production potential is very low. The most drought-

tolerant forage species grow best. Suitable species include western wheatgrass, crested wheatgrass, green needlegrass, intermediate wheatgrass, and pubescent wheatgrass.

Wet pasture group. This group of soils is wet. The production potential is very high. The best suited forage species are those that are tolerant of wetness and inundation. Suitable species include reed canarygrass, creeping foxtail, big bluestem, switchgrass, indiangrass, meadow foxtail, and alsike clover.

Management of Saline and Sodic Soils

Saline and sodic soils make up about 13 percent of Foster County. Saline soils make up about 8 percent of the county, or 31,800 acres; sodic soils make up 4 percent, or 16,600 acres; and saline-sodic soils make up less than 1 percent, or 5,000 acres.

Saline soils have a high concentration of soluble salts, or salts that dissolve in water. The saline soils in Foster County are phases of the Arveson, Colvin, Hamerly, Lallie, and Vallers series.

Saline soils generally develop in areas of restricted drainage adjacent to natural sloughs and drainageways. Where drainage is poor, salts rise with the water table and are concentrated near the surface. This salt buildup is reduced by plants and a surface cover. The plant roots use the soil water before it can reach the surface and before the salts accumulate. The surface cover prevents evaporation at the surface, the upward movement of water in the soil, and the concentration of salts at the surface.

Plants growing on saline soils absorb salts from the water in the soils. Excess amounts of certain salts may interfere with plant growth. High concentrations of some salts are toxic to certain plants. Some salts cause nutritional imbalances or deficiencies by restricting the uptake or availability of certain plant nutrients. Detecting salinity by visual observations in the field is difficult. The salts are generally not visible during much of the growing season, particularly when the soil is moist. Flecks, threads, or masses of soluble salts are usually visible when the soil is dry. Laboratory analysis is needed to determine the actual degree of salinity in soils.

Crop response, particularly during periods of soil moisture stress, is a useful indicator of the degree of salinity in saline soils. For instance, a small grain crop growing on saline soils tends to be stunted and has fewer tillers than small grain on nonsaline soils. Strongly saline soils are best suited to native grasses or to salt-tolerant introduced grasses. Slightly saline or moderately saline soils can be used for salt-tolerant crops and forage. Barley is the most salt tolerant of the small grains. Of the forage crops, tall wheatgrass, western wheatgrass, and alfalfa are salt tolerant once they are established.

Sodic soils are characterized by a high content of exchangeable sodium, which adheres to the clay particles in the soils. The sodic soils in Foster County are those of the Cathay, Larson, and Letcher series. Locally, sodic soils are known as "black alkali," "slick spots," "pan spots," or "gumbo."

Sodic soils develop in a complex pattern with a very distinct microrelief. The physical and chemical properties of these soils differ markedly within very short distances. In many areas the distance between the sodic soils and the surrounding soils that have normal physical properties is only a few feet, perhaps 5 to 10 feet.

Sodic soils develop in areas of saline soils that contain large quantities of sodium salts. Over a long period, usually centuries, rainwater gradually leaches the salts from the surface to the lower horizons as the water table lowers. During this leaching process, the clay in the soils becomes saturated with sodium, disperses, and moves downward with the percolating water. As the moving clay concentrates, a dense, sodic subsoil forms. The dense subsoil is hard when dry, sticky when wet, and nearly impervious to roots, water, and air (fig. 10). Larson soils are an example of soils that have a dense, sodic subsoil.

As leaching by water in the soils continues, the sodium is gradually moved lower in the profile and eventually is carried below the rooting depth. The result is a more manageable soil, such as Cathay soils. If the leaching process continues and nearly all of the sodium is removed from the profile, the soil eventually changes into a nonsodic soil. This change requires a long period, usually centuries *(6)*.

If plowed, sodic soils are characterized by a surface layer that is sticky when wet and hard and cloddy when dry. A crust forms easily at the surface. The chemical and physical properties of these soils do not favor plant growth. The harmful effects of the properties on plants generally increase as the sodium content increases. The effects of the reduced amount of water available to plants are more harmful than the toxic effect of the sodium. The plants also are affected by depth to the dense subsoil.

Identification of sodic soils in cultivated fields commonly is difficult because many of the physical characteristics, such as columnar structure, have been altered by tillage. Crop response, particularly during periods of moisture stress, is a useful indicator of the level of sodicity in a soil. Crops growing on soils that

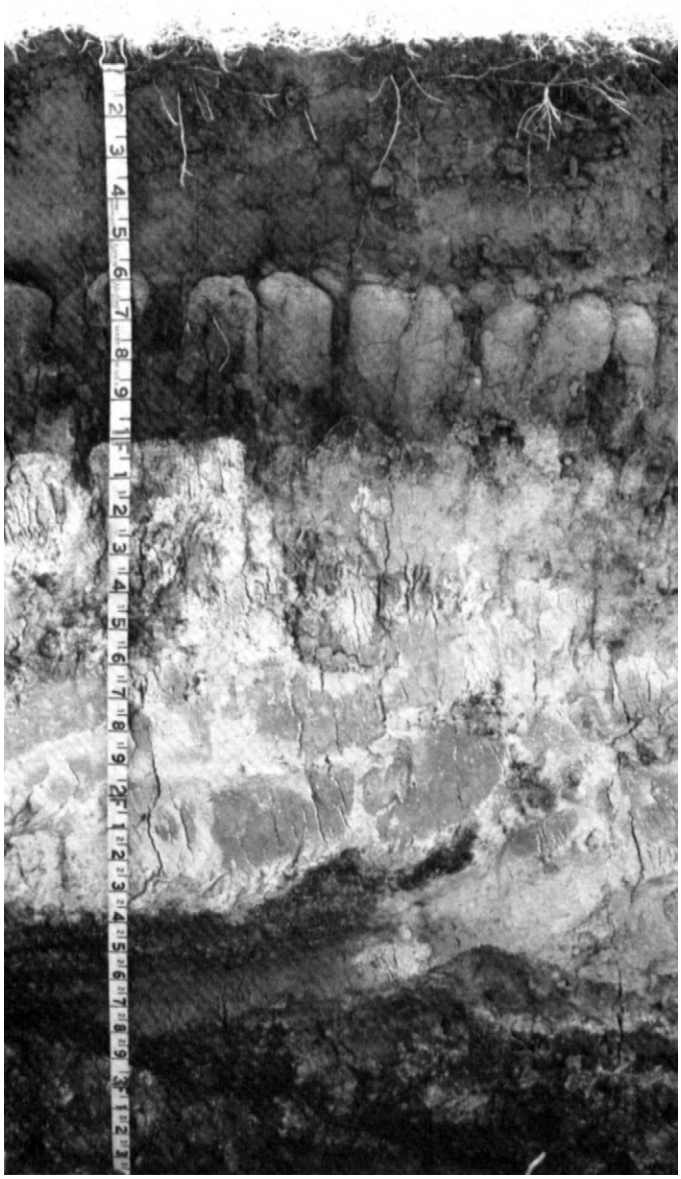

Figure 10.—A sodic soil having a dense subsoil that restricts the penetration of roots. Roots generally penetrate only the parings between the columns that are at a depth of 0.6 to 1.0 foot. The light-colored subsoil at a depth of 1.0 to 2.4 feet is the result of an accumulation of lime. (The scale is in feet and tenths of feet.)

have varying amounts of sodium exhibit varying heights and stages of development. If the level of sodicity is very high, the crop cannot grow. The effects of sodium on crop growth are influenced by weather conditions, the stage of crop growth, and soil moisture. A measure of the effect of sodicity on plant growth is not necessarily a reliable measure of crop yields. In many areas the yields of barley and wheat are affected less than the growth of these crops.

The variability of sodic soils can cause management problems. The sodic soils that have salts within a depth of 16 inches, such as Miranda soils, are generally best suited to native grasses. The soils that have a dense, sodic subsoil near the surface are generally unsuited to small grain and sunflowers.

Timely tillage is important in areas of leached sodic soils, such as Cathay soils. These areas should be tilled and seeded only when the moisture content is favorable. If worked when too wet, the soils puddle and crust. If the soils are tilled when too dry, tillage and seeding implements cannot easily penetrate the soils. Deep plowing and chemical amendments can help to reclaim sodic soils, but they may not be feasible. To be effective, deep tillage should reach to the sodic subsoil and mix several inches of the underlying material with the subsoil and topsoil. Depending on the soil, tillage to a depth of 15 to 36 inches may be needed. Any reclamation of sodic soils is a long-term endeavor. Complete reclamation may never be achieved. Onsite investigation is needed to confirm the feasibility of deep tillage in a particular area.

Saline-sodic soils develop in areas of restricted drainage where salts rise with the water table but where some downward leaching of clay and some saturation with sodium are evident and a dense, sodic subsoil has formed. The saline-sodic soils in Foster County are those of the Manfred and Miranda series. The management needs and crop responses on these soils are a combination of those on saline soils and those on sodic soils.

Additional information about management or reclamation of saline and sodic soils is available from the Soil Conservation Service, the North Dakota Agricultural Experiment Station, and the North Dakota Cooperative Extension Service.

Productivity Index

The productivity index is a relative rating of the ability of a particular map unit to produce a particular crop yield in comparison to other map units. The index ranges from 0, which indicates no yield, to 100, which indicates the highest yield. When the index is calculated, the similar and contrasting inclusions are considered along with the major soils. In Foster County a productivity index of 100 was considered equal to an average yield of 40 bushels per acre of spring wheat. Multiplying the productivity index by 40 and then dividing the product by 100 converts the index number to a figure representing the expected average yield per acre. Cathay-Heimdal loams, 1 to 3 percent slopes, for

example, has a productivity index of 75. This number multiplied by 40 and then divided by 100 converts to 30, which is the expected average annual yield of spring wheat in bushels per acre for this map unit (see table 5).

Yields per Acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 5. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors.

The yields are based mainly on the experience and records of farmers, conservationists, and extension agents. Available yield data from nearby counties and results of field trials and demonstrations are also considered.

The management needed to obtain the indicated yields of the various crops depends on the kind of soil and the crop. Management can include drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate and timely tillage; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residue, barnyard manure, and green manure crops; and harvesting that ensures the smallest possible loss.

The estimated yields reflect the productive capacity of each soil for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 5 are grown in the survey area, but estimated yields are not listed because the acreage of such crops is small. The local office of the Soil Conservation Service or of the Cooperative Extension Service can provide information about the management and productivity of the soils for those crops.

Land Capability Classification

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops *(12)*. Crops that require special management are excluded. The soils are grouped according to their limitations for field crops, the risk of damage if they are used for crops, and the way they respond to management. The criteria used in grouping the soils do not include major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor do they include possible but unlikely major reclamation projects. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for rangeland, for woodland, and for engineering purposes.

In the capability system, soils are generally grouped at three levels—capability class, subclass, and unit. Only class and subclass are used in this survey.

Capability classes, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:

Class I soils have few limitations that restrict their use.

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants or that require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants or that require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and miscellaneous areas have limitations that nearly preclude their use for commercial crop production.

Capability subclasses are soil groups within one class. They are designated by adding a small letter, *e, w, s,* or *c,* to the class numeral, for example, IIe. The letter *e* shows that the main hazard is the risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is very cold or very dry.

In class I there are no subclasses because the soils of this class have few limitations. Class V contains only the subclasses indicated by *w, s,* or *c* because the soils in class V are subject to little or no erosion. They have other limitations that restrict their use to pasture, rangeland, woodland, wildlife habitat, or recreation.

The capability classification of each map unit is given in the section "Detailed Soil Map Units."

Rangeland

A. Dean Chamrad and Anthony D. Miller, range conservationists, Soil Conservation Service, helped prepare this section.

The native vegetation on rangeland consists of a wide variety of grasses, grasslike plants, forbs, shrubs, and trees. Generally, the plants are suitable for grazing and the plant cover is sufficiently productive to justify grazing. Cultural treatments, such as applications of fertilizer and cultivation, generally are not used or needed to maintain the productivity of rangeland. The composition and production of the plant community are largely determined by soil, climate, topography, and grazing management.

In 1990, approximately 41,000 acres in Foster County, or nearly 10 percent of the total acreage, was rangeland. In areas where it is properly managed, this rangeland is similar to the presettlement prairie of the late 1800's and the early 1900's. Most of the rangeland is on loamy glacial till plains and moraines. Much of it occurs as hilly to very steep, well drained or excessively drained soils or as level and nearly level, poorly drained and very poorly drained soils in potholes and depressions. The soils are generally unsuited or poorly suited to cultivated crops.

In 1990, the farms and ranches in the county had about 19,000 head of cattle, including about 300 milk cows *(17)*. Most of the ranches are cow-calf enterprises. Some also run stocker yearlings, which add flexibility during periods of low or high forage production. On a few of the farms, raising sheep in conjunction with cattle improves the efficiency of range utilization and results in greater economic stability. In 1990, the number of sheep in the county was about 3,400 *(17)*.

Because of a relatively short growing season, many farmers and ranchers have established cool-season tame pastures to supplement the forage produced on rangeland and to extend the grazing season in the spring and fall. Droughts of short duration are common. They reduce the benefits derived from cool-season pastures in some years. Generally, large quantities of hay and feed are needed because of the long winters. Hay was harvested on about 25,000 acres in the county in 1990 *(17)*.

Range Sites and Condition Classes

In areas that have similar climate and topography, differences in the kind and amount of vegetation produced on rangeland are closely related to the kind of soil. Effective management is based on the relationships among soils, vegetation, and water.

Soils vary in their capacity to produce grasses and other plants suitable for grazing. Soils that produce similar kinds, proportions, and amounts of vegetation are grouped into a range site.

Each range site has a distinctive potential plant community that is referred to as the climax vegetation. The climax vegetation is relatively stable and indicates what the range site is capable of producing. It reproduces itself annually and changes very little as long as the environment remains unchanged. The climax vegetation on the prairie consists of the kinds of plants that grew when the region was settled. It is generally the most productive combination of plants that can be grown on the site. When the site is improperly grazed, some of the climax plants decrease in quantity, while others increase. Also, plants that were not part of the original native plant community may invade the site.

Decreaser plants are the species that decrease in quantity under heavy, continuous grazing. They generally are the most palatable to livestock.

Increaser plants are the species that initially increase in quantity under heavy, continuous grazing at the expense of the decreaser species. They generally are less palatable to livestock than the decreaser species. Under prolonged heavy grazing the increaser plants also eventually decrease in quantity.

Invader plants are species that normally are not part of the climax plant community because they cannot compete with the climax vegetation for moisture, nutrients, and light. They invade the site only after the extent of the climax vegetation has been reduced by heavy, continuous grazing or other disturbance. Most invader species have limited value as forage. All nonendemic species are invaders in natural plant communities.

Range condition classes indicate the present composition of the plant community on a range site in relation to the climax vegetation. Range condition is determined by comparing the present plant community with the potential natural plant community on a particular range site. The more closely the existing community resembles the potential community, the better the range condition. Range condition is an ecological rating only. It is not a rating of forage value. It is expressed as excellent, good, fair, or poor, depending on how closely the present plant community resembles the natural potential plant community. *Excellent* indicates that 76 to 100 percent of the present plant community is the same as the climax vegetation; *good*, 51 to 75 percent; *fair*, 26 to 50 percent; and *poor*, 25 percent or less.

Potential forage production depends on the kind of range site. Current forage production depends on the range condition and the amount of moisture available to the plants during the growing season.

Table 6 shows, for most of the soils in the county,

the range site and the potential annual production of vegetation in favorable, average, and unfavorable years. Only those soils that are used as rangeland or are suited to rangeland are listed. An explanation of the column headings in table 6 follows.

A *range site* is a distinctive kind of rangeland that produces a characteristic natural plant community that differs from natural plant communities on other range sites in kind, amount, and proportion of range plants. The relationship between soils and vegetation was ascertained during this survey; thus, range sites generally can be determined directly from the soil map. Soil properties that affect moisture supply and plant nutrients have the greatest influence on the productivity of range sites. Soil reaction, salt content, and a seasonal high water table also are important.

Potential annual production is the amount of vegetation that can be expected to grow annually on well managed rangeland that is supporting the potential natural plant community. It includes all vegetation, whether or not it is palatable to grazing animals. It includes the current year's growth of leaves, twigs, and fruits of woody plants. It does not include the increase in stem diameter of trees and shrubs. Production is expressed in pounds per acre of air-dry vegetation for favorable, average, and unfavorable years. In a favorable year, the amount and distribution of precipitation and the temperatures make growing conditions substantially better than average. In an unfavorable year, growing conditions are well below average, generally because of low available soil moisture or above average temperatures.

Yields are adjusted to a common percent of air-dry moisture content. The relationship of green weight to air-dry weight varies according to such factors as kind of exposure, amount of shade, recent rains, and unseasonably dry periods.

Range management requires a knowledge of the kinds of soil and of the potential natural plant community. It also requires an evaluation of the present range condition. The primary objective in range management is to control grazing so that the plants growing on a site are about the same in kind and amount as the potential natural plant community for that site. Such management generally results in the optimum production of vegetation, control of undesirable brush and weeds, conservation of water, and control of erosion. Sometimes, however, a range condition somewhat below the potential meets grazing needs, provides wildlife habitat, and protects soil and water resources.

Ecologically sound range management maintains excellent or good range condition. Water is conserved, yields are optimized, and soils are protected. An important management concern is recognizing the changes in the plant community that take place gradually and that can be misinterpreted or overlooked. Growth encouraged by heavy rainfall, for example, may lead to the conclusion that the range is in good condition, when the plant cover actually is weedy and the long-term trend is toward lower production. On the other hand, some rangeland that has been grazed closely for a short period may have a degraded appearance that temporarily obscures its quality and ability to recover rapidly.

Rangeland can recover from prolonged overuse if the climax decreaser species have not been completely grazed out. If overgrazing is stopped, enough climax plants generally remain for proper grazing use, deferred grazing, and a grazing system to restore the rangeland to excellent condition. In areas where the climax plant community has been destroyed, range seeding can accelerate improvement of the range condition. Seeding the proper climax species also can restore productive rangeland in areas of depleted or low-quality cropland. Brush control, development of water facilities, fences, and other mechanical practices may be needed to facilitate proper grazing management. Proper grazing management is the key to maintaining or improving the productivity and diversity of rangeland.

Range Sites

The following paragraphs describe the range sites in Foster County. The names of these sites are Clayey, Claypan, Limy Subirrigated, Overflow, Saline Lowland, Sands, Sandy, Sandy Claypan, Shallow to Gravel, Silty, Subirrigated, Thin Claypan, Thin Upland, Very Shallow, Wetland, and Wet Meadow.

Clayey range site. This site is dominated by a mixture of cool-season, mid grasses and an understory of short grasses. The principal species are western wheatgrass, porcupinegrass, needleandthread, and green needlegrass. The understory plants are blue grama, prairie junegrass, Pennsylvania sedge, and other upland sedges. Forbs, such as western yarrow, scarlet globemallow, and green sagewort, make up about 10 percent of the total herbage. The most common woody plants are western snowberry and prairie rose.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as western wheatgrass, porcupinegrass, green needlegrass, and prairie junegrass. The plants that increase in abundance under these conditions are blue grama, needleandthread, and upland sedges. Further deterioration results in a dominance of blue grama,

upland sedges, western ragweed, and fringed sagewort and the invasion of Kentucky bluegrass.

Very few problems affect management of this site. The rate of water infiltration is slow. As a result, an adequate cover of vegetation is needed to help ensure that forage production is not reduced by runoff. Areas where the range is in fair condition can generally be restored to good or excellent condition by proper grazing management if the climax species remain in sufficient numbers and are uniformly distributed.

Claypan range site. The climax vegetation on this site is primarily a mixture of short and mid grasses, sedges, and forbs. The principal species are western wheatgrass, green needlegrass, needleandthread, and prairie junegrass. Other species are blue grama and upland sedges. The most common forbs are scarlet globemallow, silver scurfpea, rush skeletonplant, and fringed sagewort.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as green needlegrass, prairie junegrass, needleandthread, and western wheatgrass. The plants that increase in abundance under these conditions are inland saltgrass, blue grama, Sandberg bluegrass, and upland sedges. Further deterioration results in a dominance of blue grama, inland saltgrass, upland sedges, fringed sagewort, broom snakeweed, and annual grasses and forbs.

This site is easily damaged by overgrazing. Because of a dense subsoil and salts in the soils, reestablishing vegetation is difficult in denuded areas. Careful management that maintains an abundance of the naturally dominant plants is the best way to maintain forage production and protect the soil from water erosion.

Limy Subirrigated range site. Tall and mid grasses dominate this site. The principal species are little bluestem, big bluestem, and switchgrass. Other species are indiangrass, slim sedge, fescue sedge, and Baltic rush. Forbs, including Maximilian sunflower, stiff sunflower, American licorice, and Missouri goldenrod, make up about 10 percent of the total herbage.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as big bluestem, indiangrass, switchgrass, Maximilian sunflower, and stiff sunflower. Little bluestem increases initially in abundance under these conditions, but it eventually decreases. Further deterioration results in a dominance of Baltic rush, common spikerush, and annual grasses and forbs and the invasion of Kentucky bluegrass.

Because of the high percentage of warm-season grasses, this site can provide high-quality forage late in the growing season. In areas where the plant community has deteriorated from its potential, deferment of grazing during the growing season or a planned grazing system and proper grazing use can restore the site. In areas where the potential plant community has been destroyed by cultivation or by extremely severe overuse, range seeding can reestablish the major species of grasses.

Overflow range site. Both tall and mid grasses are dominant when this site is in excellent condition. The principal species are big bluestem, green needlegrass, western wheatgrass, and needleandthread. Other species are porcupinegrass, prairie dropseed, switchgrass, fescue sedge, and little bluestem. Several forbs, such as Maximilian sunflower, soft goldenrod, cudweed sagewort, and heath aster, make up about 10 percent of the total herbage. Several woody plants, such as western snowberry, buffaloberry, and common chokecherry, commonly grow on the site, depending on the position on the landscape. They may make up about 5 percent of the total herbage.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as big bluestem, green needlegrass, prairie dropseed, and switchgrass. The plants that increase in abundance under these conditions are western wheatgrass, blue grama, Pennsylvania sedge, and fescue sedge. Further deterioration results in a dominance of blue grama, sedges, and unpalatable forbs and the invasion of Kentucky bluegrass.

Because of its position on the landscape, this site is frequently overgrazed. Separate fencing of this site generally is not feasible because of the small size or the shape of areas of the site. Because it is subject to flooding and receives runoff from the adjacent areas, this site is very productive when properly managed. A planned grazing system can help to restore the site and maintain a high level of productivity. Reseeding is needed in areas that have been farmed. In areas where shrubs dominate, brush management can help to restore productivity.

Saline Lowland range site. Salt-tolerant, mid grasses dominate this site. The principal species are Nuttall alkaligrass, inland saltgrass, alkali cordgrass, and other salt-tolerant species, including western wheatgrass and slender wheatgrass. Other species are alkali muhly, plains bluegrass, foxtail barley, and prairie bulrush. Forbs, such as western dock, silverweed cinquefoil, and Pursh seepweed, make up about 10 percent of the total herbage.

Continual heavy grazing by cattle results in a

decrease in the abundance of such plants as Nuttall alkaligrass, slender wheatgrass, western wheatgrass, and alkali cordgrass. The plants that increase in abundance under these conditions are inland saltgrass, alkali muhly, foxtail barley, and mat muhly. Further deterioration results in a dominance of inland saltgrass, foxtail barley, silverweed cinquefoil, and western dock.

A high content of salts and a restricted available water capacity limit forage production on this site. Careful management of the adapted, desirable salt-tolerant plants can maintain good forage production. If the plant community has been severely damaged, however, the site recovers slowly. Soil blowing and water erosion are hazards in denuded areas. Livestock ponds on this site frequently contain salty water. If feasible, alternative water sources should be developed.

Sands range site. The principal grasses on this site are prairie sandreed, needleandthread, and sand bluestem. Other species are blue grama, prairie junegrass, sand dropseed, western wheatgrass, and upland sedges. Forbs make up about 10 percent of the total herbage. This site has a small amount of woody species, such as prairie rose, western snowberry, and leadplant amorpha.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as prairie sandreed, little bluestem, sand bluestem, and leadplant amorpha. Needleandthread initially increases in abundance, but it eventually decreases. Other plants that increase in abundance under these conditions are sand dropseed, blue grama, upland sedges, and several forbs. Further deterioration results in a dominance of blue grama, upland sedges, and unpalatable forbs, such as fringed sagewort and cudweed sagewort.

A low or very low available water capacity and the hazard of soil blowing are concerns in managing this site. Measures that minimize the formation of livestock trails and the concentration of livestock are needed. In severely overgrazed areas, blowouts are common. In areas of large blowouts, shaping, seeding, and mulching are needed before the climax vegetation can be reestablished. In areas where this site is in fair or poor condition, the vegetation responds rapidly to improved grazing management.

Sandy range site. The principal grasses on this site are needleandthread, prairie sandreed, blue grama, and western wheatgrass. Other species are prairie junegrass, sand dropseed, green needlegrass, and upland sedges. The site generally has a number of early season forbs, such as western yarrow, green sagewort, and Missouri goldenrod. Woody plants, such as western snowberry and leadplant amorpha, make up about 5 percent of the total herbage.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as western wheatgrass, green needlegrass, prairie sandreed, and leadplant amorpha. The plants that increase in abundance under these conditions are blue grama, upland sedges, sand dropseed, needleandthread, and several forbs. Further deterioration results in a dominance of blue grama, upland sedges, and unpalatable forbs, such as western yarrow, green sagewort, and cudweed sagewort.

A moderate available water capacity is a concern in managing this site. Also, soil blowing is a hazard in denuded areas. Management that maintains an abundance of the key species results in a natural plant community that provides excellent forage for livestock and a protective plant cover.

Sandy Claypan range site. Short grasses dominate this site. The principal species are western wheatgrass, needleandthread, and blue grama. Other species are sun sedge, other upland sedges, and a small number of perennial forbs. The most common woody plants and half-shrubs are fringed sagewort and western snowberry.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as western wheatgrass and needleandthread. The plants that increase in abundance under these conditions are blue grama, upland sedges, and fringed sagewort. Further deterioration results in a dominance of blue grama, upland sedges, fringed sagebrush, annual forbs, and annual grasses.

Forage production varies on this site. The soils have a dense, sodic subsoil and a restricted available water capacity. The site is fragile, and the natural plant community can deteriorate rapidly. Management that maintains a protective plant cover is needed to control erosion.

Shallow to Gravel range site. A mixture of cool- and warm-season, mid grasses dominates this site. The principal species are western wheatgrass, needleandthread, green needlegrass, and blue grama. Other species are plains muhly, prairie junegrass, red threeawn, porcupinegrass, and upland sedges. Forbs make up about 10 percent of the total herbage. The site has only a small amount of woody plants.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as green needlegrass, western wheatgrass, plains muhly, and prairie junegrass. The plants that increase in abundance under these conditions are blue grama, red

threeawn, and upland sedges. Further deterioration results in a dominance of blue grama, upland sedges, fringed sagewort, and annual forbs.

A low available water capacity limits forage production on this site. The site is fragile, and the plant community can deteriorate rapidly. Keeping the plant community near its potential and maintaining the vigor of key plants help to optimize the use of the limited amount of available moisture.

Silty range site. Mid grasses dominate this site. The principal species are western wheatgrass, green needlegrass, needleandthread, and blue grama. Other species are prairie junegrass, prairie dropseed, and upland sedges. Forbs include wooly goldenrod, stiff sunflower, and western yarrow. The site has minor amounts of woody species.

Continual heavy grazing by cattle results in a decrease in the abundance of green needlegrass, western wheatgrass, prairie junegrass, and porcupinegrass. The plants that increase in abundance under these conditions are needleandthread, blue grama, threadleaf sedge, needleleaf sedge, and fringed sagewort. Further deterioration results in a dominance of blue grama, threadleaf sedge, needleleaf sedge, fringed sagewort, green sagewort, and other forbs. As the range condition deteriorates, woody species increase in abundance and Kentucky bluegrass invades.

Generally, no major problems affect management of this site. In the more sloping areas, however, gullies can form along livestock trails. Proper grazing use and planned grazing systems help to prevent gullying. Areas where the range is in fair or poor condition generally can be restored to good or excellent condition by sound grazing management. Brush management is needed in areas where undesirable woody species have increased in abundance or invaded.

Subirrigated range site. Tall and mid grasses dominate this site. The principal species are big bluestem, switchgrass, prairie cordgrass, little bluestem, and northern reedgrass. Other species are indiangrass, western wheatgrass, tall dropseed, and slender wheatgrass. The site has minor amounts of sedges and rushes. A variety of forbs makes up about 10 percent of the total herbage.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as big bluestem, switchgrass, prairie cordgrass, northern reedgrass, indiangrass, and little bluestem. The plants that increase in abundance under these conditions are mat muhly, fowl bluegrass, Baltic rush, common spikerush, and various forbs. Further deterioration results in the invasion of Kentucky bluegrass and a dominance of short grasses, grasslike plants, and undesirable forbs.

Because of a high percentage of warm-season grasses, this site can provide high-quality forage late in the growing season. In areas where the plant community has deteriorated from its potential, deferment of grazing during the growing season or a planned grazing system in conjunction with proper grazing use can restore the site. In areas where the potential plant community has been destroyed by cultivation or by extremely severe overuse, range seeding can reestablish the major species of grasses.

Thin Claypan range site. Mid and short grasses dominate this site. The principal species are western wheatgrass, blue grama, inland saltgrass, and Sandberg bluegrass. Other species are prairie junegrass, needleandthread, Nuttall alkaligrass, alkali muhly, and needleleaf sedge. Forbs make up about 5 percent of the total herbage.

Continual heavy grazing by cattle results in a decrease in the abundance of western wheatgrass, prairie junegrass, and needleandthread. The plants that increase in abundance under these conditions are blue grama, inland saltgrass, Sandberg bluegrass, and alkali muhly. Further deterioration results in a dominance of short grasses, sedges, fringed sagewort, annual forbs, and cactus.

Because of salts near the surface of the soils, productivity is quite low on this site. The site produces good-quality forage for cattle only if properly managed. If the site is in poor or fair condition, recovery is quite slow because of the salts and a dense, sodic subsoil. Livestock ponds should not be constructed on this site because the water is likely to be salty. Sound management can restore the site to good or excellent condition. If the vegetation has been destroyed by cultivation or the site is denuded, range seeding can restore desirable vegetation but good seeding techniques are essential.

Thin Upland range site. Cool- and warm-season, mid grasses dominate this site. The principal species are little bluestem, needleandthread, western wheatgrass, and sideoats grama. Other species are plains muhly, blue grama, prairie dropseed, bearded wheatgrass, and upland sedges. Forbs include pasqueflower, purple prairie-clover, and dotted gayfeather. The site has minor amounts of woody plants, such as silverberry and western snowberry.

Continual heavy grazing by cattle results in a decrease in the abundance of little bluestem, needleandthread, western wheatgrass, and sideoats

grama. The plants that increase in abundance under these conditions are blue grama, red threeawn, upland sedges, and unpalatable forbs. Further deterioration results in a dominance of blue grama, upland sedges, and fringed sagewort; the invasion of Kentucky bluegrass; and an increase in the abundance of woody species.

Generally, no major problems affect management of this site. In the more sloping areas, however, gullies can form along livestock trails. Gullying can be prevented by proper grazing management and by cross-fencing, which helps to control livestock traffic patterns. Soil blowing is a problem in denuded areas. Areas where the range is in fair or poor range condition generally can be restored to good or excellent condition by sound grazing management. In some areas brush control is needed.

Very Shallow range site. This site has a mixture of cool- and warm-season, mid and short grasses. The principal species are needleandthread, western wheatgrass, blue grama, and plains muhly. Other species are prairie junegrass, red threeawn, sideoats grama, and upland sedges. Forbs and woody plants make up about 15 percent of the total herbage.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as needleandthread, western wheatgrass, sideoats grama, and plains muhly. The plants that increase in abundance under these conditions are blue grama, red threeawn, sand dropseed, and upland sedges. Further deterioration results in a dominance of blue grama, red threeawn, upland sedges, and undesirable forbs and shrubs.

Available water capacity is very low on this site. Also, water erosion is a hazard in the more sloping areas. Gullies can form readily along cattle trails and in denuded areas. The site is frequently spot grazed. Once it has deteriorated to fair or poor condition, it recovers slowly because of the very low available water capacity. Productivity can be maintained by sound grazing management of the mid grasses.

Wetland range site. Hydrophytic vegetation dominates this site. The principal species are rivergrass, prairie cordgrass, northern reedgrass, slough sedge, and slim sedge. Other species are American mannagrass, American sloughgrass, Baltic rush, and common spikesedge. Common forbs are longroot smartweed and waterparsnip. Shrubs generally do not grow on this site.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as rivergrass, slough sedge, prairie cordgrass, and northern reedgrass. The plants that increase in abundance under these conditions are slim sedge, Baltic rush, common spikesedge, and American sloughgrass. Further deterioration results in a dominance of Baltic rush, common spikesedge, and Mexican dock.

Generally, this site is subject to lighter grazing pressure than the adjacent upland sites. It is more heavily grazed during droughty periods. This site is easily damaged if it is grazed when wet. Grazing during wet periods results in compaction, trampling, and root shearing. A planned grazing system and deferment of grazing when the site is wet helps to maintain the climax vegetation and the important elements of wetland wildlife habitat.

Wet Meadow range site. Sedges and mid grasses dominate this site. The principal species are slim sedge, wooly sedge, fescue sedge, prairie cordgrass, and northern reedgrass. Other species are Baltic rush, common spikerush, fowl bluegrass, and switchgrass. Common forbs are Rydberg sunflower, tall white aster, and common wild mint.

Continual heavy grazing by cattle results in a decrease in the abundance of slim sedge, wooly sedge, northern reedgrass, prairie cordgrass, and switchgrass. The plants that increase in abundance under these conditions are fescue sedge, common spikerush, Baltic rush, mat muhly, and fowl bluegrass. Further deterioration results in a dominance of low-growing sedges, short grasses, western dock, and Canada thistle.

Generally, this site is subject to lighter grazing pressure than the adjacent upland sites. It is more heavily grazed during droughty periods. This site is easily damaged if it is grazed when wet. Grazing during wet periods results in compaction, trampling, and root shearing. A planned grazing system that includes strategic fencing helps to maintain the climax vegetation. The site is an excellent source of quality hay.

Woodland, Windbreaks, and Environmental Plantings

Prepared by Bruce C. Wight, forester, Soil Conservation Service.

Foster County has only about 200 acres of native woodland *(7)*. This woodland is in scattered small areas throughout the county. The areas along the James River and its tributaries have little, if any, wooded vegetation. Trees and shrubs are along the northwestern end of Lake George, near Bordulac in the south-central part of the county. Woody draws are in scattered areas on some of the rangeland and pastureland. Trees and shrubs are also on the fringe of

wetlands in the southwest corner of the county. The trees along Lake George are mostly in areas of Arveson, Hamerly, and Vallers loams. The woodland in the woody draws is primarily in areas of Barnes, Emrick, and Heimdal loams. The woodland on the fringe of the wetlands is mostly in areas of Fram, Hamerly, Vallers, and Wyard loams.

The dominant forest type in Foster County is American elm and green ash. The less common species include boxelder, bur oak, hawthorn, American plum, chokecherry, golden currant, juneberry, redosier dogwood, Wood's rose, snowberry, and silver buffaloberry. The dominant forest type in the woody draws is green ash. Shrubs are also dominant in the woody draws and are interspersed with green ash and American elm. The principal species on the wooded fringe of the wetlands are plains cottonwood, quaking aspen, various willow species, and redosier dogwood.

The early settlers used the trees for fuel, lumber, and fenceposts. Currently, there is a renewed interest in using the trees for fuel, but the principal uses are for protection and esthetic purposes. The trees protect the soils, homes, livestock, wildlife, and watersheds.

Windbreaks have been planted in Foster County since the early days of settlement. Some of these early plantings were made under the Timber Culture Act. Under this act, 160 acres of land was granted to a homesteader who planted 10 acres to trees. Most of the early plantings were made to protect farmsteads and livestock. In the 1930's, approximately 925 acres was planted to trees and shrubs under the Prairie States Forestry Project of the U.S. Department of Agriculture, Forest Service.

Since the 1903's, more than 2,700,000 trees have been planted on about 3,800 acres by county farmers and landowners assisted by the Soil Conservation Service and the Foster County Soil Conservation District. Trees and shrubs are still needed around numerous farmsteads in the county, but the major need is for windbreaks that help to protect soils that are highly susceptible to soil blowing.

The following items should be considered before a planting is made—the purpose of the planting, the suitability of various species of trees and shrubs to the soils and the climate, the location and design of the windbreak, and the selection of hardy seedlings. If these items are not considered, a poor or unsuccessful windbreak may result.

The establishment of a windbreak or an environmental planting and the growth of the trees and shrubs also depend on suitable site preparation and adequate maintenance after the trees and shrubs are planted. Grasses and weeds should be eliminated before the trees and shrubs are planted, and the competing ground cover should be controlled for the life of the windbreak. Some replanting may be necessary during the first 2 years after the trees and shrubs are planted.

Windbreaks protect livestock, buildings, and yards from wind and snow. They also protect fruit trees and gardens, and they furnish habitat for wildlife. Several rows of low- and high-growing broadleaf and coniferous trees and shrubs provide the most protection.

Field windbreaks are narrow plantings made at right angles to the prevailing wind and at specific intervals across the field. The interval depends on the erodibility of the soil. Field windbreaks protect cropland and crops from wind (fig. 11), help to keep snow on the fields, and provide food and cover for wildlife.

Environmental plantings help to beautify and screen houses and other buildings and to abate noise. The plants, mostly evergreen shrubs and trees, are closely spaced. To ensure plant survival, a healthy planting stock of suitable species should be planted properly on a well prepared site and maintained in good condition.

Table 7 shows the height that locally grown trees and shrubs are expected to reach in 20 years on various soils. The estimates in table 7 are based on measurements and observation of established plantings that have been given adequate care. They can be used as a guide in planning windbreaks and screens. Additional information on planning windbreaks and screens and planting and caring for trees and shrubs can be obtained from local offices of the Soil Conservation Service or the Cooperative Extension Service or from a commercial nursery.

Recreation

Prepared by David D. Dewald, biologist, Soil Conservation Service.

The recreational resources of Foster County are somewhat limited. Hunting and fishing are the main recreational opportunities available to the residents of the county. Opportunities for fishing and limited primitive camping are available at Lake Juanita. Northern pike, bullhead, and perch are the main species of game fish in the waters.

One town in the county has picnicking and limited camping facilities. The county has no State or County parks.

Approximately 6,600 acres managed by the U.S. Fish and Wildlife Service provides opportunities for hunting. The North Dakota State Game and Fish Department manages approximately 160 acres of wildlife areas. About 3,100 acres of State school land is open to the public. Many private landowners grant permission to hunt on their land.

Figure 11.—Sunflowers in an area protected by a field windbreak.

The public areas in the county provide opportunities for numerous other recreational activities, including hiking, bird-watching, and cross-country skiing.

The soils of the survey area are rated in table 8 according to limitations that affect their suitability for recreation. The ratings are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to water, potential water impoundment sites, and access to public sewer lines. The capacity of the soil to absorb septic tank effluent and the ability of the soil to support vegetation are also important. Soils subject to flooding are limited for recreational uses by the duration and intensity of flooding and the season when flooding occurs. In planning recreational facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

In table 8, the degree of soil limitation is expressed as slight, moderate, or severe. *Slight* means that soil properties are generally favorable and that limitations are minor and easily overcome. *Moderate* means that limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be

offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 8 can be supplemented by other information in this survey, for example, interpretations for septic tank absorption fields in table 11 and interpretations for dwellings without basements and for local roads and streets in table 10.

Camp areas require site preparation, such as shaping and leveling the tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils have mild slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing campsites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones and boulders, is firm after rains, and is not dusty when dry. If grading is needed, the depth of the soil over bedrock or a hardpan should be considered.

Paths and trails for hiking and horseback riding should require little or no cutting and filling. The best soils are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once a year during the period of use. They have moderate slopes and few or no stones or boulders on the surface.

Wildlife Habitat

Prepared by David D. Dewald, biologist, Soil Conservation Service.

Foster County is in the prairie pothole region of North Dakota. It has diverse kinds of wildlife habitat. Since settlement, agricultural activity has reduced the quality and quantity of rangeland and wetland wildlife habitat but has increased the amount of openland wildlife habitat. About 10 percent of the original rangeland habitat remains. The diversity of the wildlife habitat is enhanced by the numerous wetlands in the county. Drainage systems installed to improve crop production have removed approximately 30 percent of the original wetland habitat. The remaining wetlands provide habitat for waterfowl and furbearers.

Private landowners have planted more than 3,540 acres of field and farmstead windbreaks, which provide habitat for resident and migratory wildlife species. Also, private landowners have protected approximately 6,600 acres of wetlands by conveying their drainage rights to the Federal Government through the Small Wetlands Acquisition Program. Private landowners manage additional areas of upland and wetland primarily for wildlife. The expanded use of no-till farming and other conservation tillage systems and the inclusion of grasses and legumes in the cropping system have increased the amount of food and cover for migratory waterfowl and resident wildlife.

The public lands in Foster County provide excellent wildlife habitat. The U.S. Fish and Wildlife Service manages about 1,500 acres as waterfowl production areas and an additional 120 acres as easement refuges. The North Dakota State Game and Fish Department manages approximately 160 acres of wildlife areas.

Important game bird species in the county are gray partridge, ring-necked pheasant, ducks, geese, mourning dove, sharp-tailed grouse, and sandhill crane. The mammals that are hunted in the county include red fox, coyote, white-tailed deer, muskrat, mink, raccoon, badger, cottontail rabbit, and white-tailed jackrabbit.

A variety of fish species inhabits the waters in the county. Northern pike, perch, and bullhead are the major species. Most of the fish are in Lake Juanita. The potential for developing additional fishery resources is limited.

Soils affect the kind and amount of vegetation that is available to wildlife as food and cover. They also affect the construction of water impoundments. The kind and abundance of wildlife depend largely on the amount and distribution of food, cover, and water. Wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by promoting the natural establishment of desirable plants.

In table 9, the soils in the survey area are rated according to their potential for providing habitat for various kinds of wildlife. This information can be used in planning parks, wildlife refuges, nature study areas, and other developments for wildlife; in selecting soils that are suitable for establishing, improving, or maintaining specific elements of wildlife habitat; and in determining the intensity of management needed for each element of the habitat.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* indicates that the element or

kind of habitat is easily established, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected. A rating of *fair* indicates that the element or kind of habitat can be established, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* indicates that limitations are severe for the designated element or kind of habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* indicates that restrictions for the element or kind of habitat are very severe and that unsatisfactory results can be expected. Creating, improving, or maintaining habitat is impractical or impossible.

The elements of wildlife habitat are described in the following paragraphs.

Grain and seed crops are domestic grains and seed-producing herbaceous plants. Soil properties and features that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flooding. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are corn, wheat, oats, and barley.

Grasses and legumes are domestic perennial grasses and herbaceous legumes. Soil properties and features that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flooding, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are intermediate wheatgrass, tall wheatgrass, bromegrass, clover, and alfalfa.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds. Soil properties and features that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flooding. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are bluestem, goldenrod, western wheatgrass, and blue grama.

Shrubs are bushy woody plants that produce fruit, buds, twigs, bark, and foliage. Soil properties and features that affect the growth of shrubs are depth of the root zone, available water capacity, salinity, and soil moisture. Examples of shrubs are common chokecherry, buffaloberry, snowberry, and juneberry.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites. Submerged or floating aquatic plants are excluded. Soil properties and features affecting wetland plants are texture of the surface layer, wetness, reaction, salinity, slope, and surface stoniness. Examples of wetland plants are smartweed, wild millet, common reedgrass, saltgrass, prairie cordgrass, bulrushes, sedges, and reeds.

Shallow water areas have an average depth of less than 5 feet. Some are naturally wet areas. Others are created by dams, levees, or other water-control structures. Soil properties and features affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. Examples of shallow water areas are marshes, waterfowl feeding areas, and ponds.

The habitat for various kinds of wildlife is described in the following paragraphs.

Habitat for openland wildlife consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The wildlife attracted to these areas include gray partridge, pheasant, western meadowlark, lark bunting, cottontail, and red fox.

Habitat for wetland wildlife consists of open, marshy or swampy shallow water areas. Some of the wildlife attracted to such areas are ducks, geese, herons, shore birds, muskrat, mink, and beaver.

Habitat for rangeland wildlife consists of areas of shrubs and wild herbaceous plants. Wildlife attracted to rangeland include deer, sharp-tailed grouse, western meadowlark, and david's sparrow.

About 51,760 acres in Foster County, or a little more than 12 percent of the total acreage, meets the requirements for hydric soils. The map units in the survey area that display hydric characteristics are listed in this section. Areas that have been artificially drained or otherwise so altered that they no longer support a predominance of hydrophytic vegetation are not identified as hydric soils on the soil maps. The list does not constitute a recommendation for a particular land use. The extent of each listed map unit is shown in table 4, and the location of each is shown on the detailed maps at the back of this publication. The soil qualities that affect use and management are described under the heading "Detailed Soil Map Units."

1	Southam silt loam
2	Parnell silty clay loam
3	Tonka silt loam
4	Manfred loam
7	Colvin silt loam, wet
8	Minnewaukan loamy fine sand
9	Lallie, saline-Minnewaukan complex
10	Colvin and Arveson, loamy substratum, soils, saline

17 Vallers and Hamerly loams, saline (Vallers part)
24 Hamerly-Parnell complex, 0 to 3 percent slopes (Parnell part)
31 Fram-Parnell complex, 0 to 3 percent slopes (Parnell part)
42 Wyndmere-Arveson complex, loamy substratum, 0 to 3 percent slopes (Arveson part)
95 Colvin and La Prairie soils, channeled (Colvin part)
102 Kratka fine sandy loam

Engineering

This section provides information for planning land uses related to urban development and to water management. Soils are rated for various uses, and the most limiting features are identified. Ratings are given for building site development, sanitary facilities, construction materials, and water management. The ratings are based on observed performance of the soils and on the estimated data and test data in the "Soil Properties" section.

Information in this section is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and construction. The information, however, has limitations. For example, estimates and other data generally apply only to that part of the soil within a depth of 5 or 6 feet. Because of the map scale, small areas of different soils may be included within the mapped areas of a specific soil.

The information is not site specific and does not eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations should be considered in planning, in site selection, and in design.

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock within 5 or 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Data were collected about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kinds of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

This information can be used to evaluate the potential of areas for residential, commercial, industrial, and recreational uses; make preliminary estimates of construction conditions; evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; plan detailed onsite investigations of soils and geology; locate potential sources of gravel, sand, earthfill, and topsoil; plan drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; and predict performance of proposed small structures and pavements by comparing the performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil maps, the soil descriptions, and other data provided in this survey, can be used to make additional interpretations.

Some of the terms used in this soil survey have a special meaning in soil science and are defined in the "Glossary."

Building Site Development

Table 10 shows the degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, and local roads and streets. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required. Special feasibility studies may be required where the soil limitations are severe.

Shallow excavations are trenches or holes dug to a maximum depth of 5 or 6 feet for basements, graves, utility lines, open ditches, and other purposes. The ratings are based on soil properties, site features, and observed performance of the soils. The ease of digging, filling, and compacting is affected by the depth to bedrock, a cemented pan, or a very firm dense layer; stone content; soil texture; and slope. The time of the year that excavations can be made is affected by the depth to a seasonal high water table and the susceptibility of the soil to flooding. The resistance of

the excavation walls or banks to sloughing or caving is affected by soil texture and depth to the water table.

Dwellings and *small commercial buildings* are structures built on shallow foundations on undisturbed soil. The load limit is the same as that for single-family dwellings no higher than three stories. Ratings are made for small commercial buildings without basements, for dwellings with basements, and for dwellings without basements. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, shrinking and swelling, and organic layers can cause the movement of footings. A high water table, depth to bedrock or to a cemented pan, large stones, slope, and flooding affect the ease of excavation and construction. Landscaping and grading that require cuts and fills of more than 5 or 6 feet are not considered.

Local roads and streets have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material; a base of gravel, crushed rock, or stabilized soil material; and a flexible or rigid surface. Cuts and fills are generally limited to less than 6 feet. The ratings are based on soil properties, site features, and observed performance of the soils. Depth to bedrock or to a cemented pan, a high water table, flooding, large stones, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil), shrink-swell potential, frost action potential, and depth to a high water table affect the traffic-supporting capacity.

Sanitary Facilities

Table 11 shows the degree and kind of soil limitations that affect septic tank absorption fields, sewage lagoons, and sanitary landfills. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required.

Table 11 also shows the suitability of the soils for use as daily cover for landfill. A rating of *good* indicates that soil properties and site features are favorable for the use and good performance and low maintenance can be expected; *fair* indicates that soil properties and site features are moderately favorable for the use and one or more soil properties or site features make the soil less desirable than the soils rated good; and *poor* indicates that one or more soil properties or site features are unfavorable for the use and overcoming the unfavorable properties requires special design, extra maintenance, or costly alteration.

Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 72 inches is evaluated. The ratings are based on soil properties, site features, and observed performance of the soils. Permeability, a high water table, depth to bedrock or to a cemented pan, and flooding affect absorption of the effluent. Large stones and bedrock or a cemented pan interfere with installation.

Unsatisfactory performance of septic tank absorption fields, including excessively slow absorption of effluent, surfacing of effluent, and hillside seepage, can affect public health. Ground water can be polluted if highly permeable sand and gravel or fractured bedrock is less than 4 feet below the base of the absorption field, if slope is excessive, or if the water table is near the surface. There must be unsaturated soil material beneath the absorption field to filter the effluent effectively. Many local ordinances require that this material be of a certain thickness.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Lagoons generally are designed to hold the sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water.

Table 11 gives ratings for the natural soil that makes up the lagoon floor. The surface layer and, generally, 1 or 2 feet of soil material below the surface layer are excavated to provide material for the embankments. The ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, a high water table, depth to bedrock or to a cemented pan, flooding, large stones, and content of organic matter.

Excessive seepage resulting from rapid permeability in the soil or a water table that is high enough to raise the level of sewage in the lagoon causes a lagoon to function unsatisfactorily. Pollution results if seepage is excessive or if floodwater overtops the lagoon. A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope, bedrock, and cemented pans can cause construction problems, and large stones can hinder compaction of the lagoon floor.

Sanitary landfills are areas where solid waste is disposed of by burying it in soil. There are two types of landfill—trench and area. In a trench landfill, the waste is placed in a trench. It is spread, compacted, and covered daily with a thin layer of soil excavated at the site. In an area landfill, the waste is placed in successive layers on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil from a source away from the site.

Both types of landfill must be able to bear heavy vehicular traffic. Both types involve a risk of ground-water pollution. Ease of excavation and revegetation should be considered.

The ratings in table 11 are based on soil properties, site features, and observed performance of the soils. Permeability, depth to bedrock or to a cemented pan, a high water table, slope, and flooding affect both types of landfill. Texture, stones and boulders, highly organic layers, soil reaction, and content of salts and sodium affect trench landfills. Unless otherwise stated, the ratings apply only to that part of the soil within a depth of about 6 feet. For deeper trenches, a limitation rated slight or moderate may not be valid. Onsite investigation is needed.

Daily cover for landfill is the soil material that is used to cover compacted solid waste in an area sanitary landfill. The soil material is obtained offsite, transported to the landfill, and spread over the waste.

Soil texture, wetness, coarse fragments, and slope affect the ease of removing and spreading the material during wet and dry periods. Loamy or silty soils that are free of large stones or excess gravel are the best cover for a landfill. Clayey soils are sticky or cloddy and are difficult to spread; sandy soils are subject to soil blowing.

After soil material has been removed, the soil material remaining in the borrow area must be thick enough over bedrock, a cemented pan, or the water table to permit revegetation. The soil material used as final cover for a landfill should be suitable for plants. The surface layer generally has the best workability, more organic matter, and the best potential for plants. Material from the surface layer should be stockpiled for use as the final cover.

Construction Materials

Table 12 gives information about the soils as a source of roadfill, sand, gravel, and topsoil. The soils are rated *good, fair,* or *poor* as a source of roadfill and topsoil. They are rated as a *probable* or *improbable* source of sand and gravel. The ratings are based on soil properties and site features that affect the removal of the soil and its use as construction material. Normal compaction, minor processing, and other standard construction practices are assumed. Each soil is evaluated to a depth of 5 or 6 feet.

Roadfill is soil material that is excavated in one place and used in road embankments in another place. In this table, the soils are rated as a source of roadfill for low embankments, generally less than 6 feet high and less exacting in design than higher embankments.

The ratings are for the soil material below the surface layer to a depth of 5 or 6 feet. It is assumed that soil layers will be mixed during excavating and spreading. Many soils have layers of contrasting suitability within their profile. The table showing engineering index properties provides detailed information about each soil layer. This information can help to determine the suitability of each layer for use as roadfill. The performance of soil after it is stabilized with lime or cement is not considered in the ratings.

The ratings are based on soil properties, site features, and observed performance of the soils. The thickness of suitable material is a major consideration. The ease of excavation is affected by large stones, a high water table, and slope. How well the soil performs in place after it has been compacted and drained is determined by its strength (as inferred from the engineering classification of the soil) and shrink-swell potential.

Soils rated *good* contain significant amounts of sand or gravel or both. They have at least 5 feet of suitable material, a low shrink-swell potential, few cobbles and stones, and slopes of 15 percent or less. Depth to the water table is more than 3 feet. Soils rated *fair* are more than 35 percent silt- and clay-sized particles and have a plasticity index of less than 10. They have a moderate shrink-swell potential, slopes of 15 to 25 percent, or many stones. Depth to the water table is 1 to 3 feet. Soils rated *poor* have a plasticity index of more than 10, a high shrink-swell potential, many stones, or slopes of more than 25 percent. They are wet and have a water table at a depth of less than 1 foot. These soils may have layers of suitable material, but the material is less than 3 feet thick.

Sand and *gravel* are natural aggregates suitable for commercial use with a minimum of processing. They are used in many kinds of construction. Specifications for each use vary widely. In table 12, only the probability of finding material in suitable quantity is evaluated. The suitability of the material for specific purposes is not evaluated, nor are factors that affect excavation of the material.

The properties used to evaluate the soil as a source of sand or gravel are gradation of grain sizes (as indicated by the engineering classification of the soil), the thickness of suitable material, and the content of rock fragments. Kinds of rock, acidity, and stratification

are given in the soil series descriptions. Gradation of grain sizes is given in the table on engineering index properties.

A soil rated as a probable source has a layer of clean sand or gravel or a layer of sand or gravel that is up to 12 percent silty fines. This material must be at least 3 feet thick and less than 50 percent, by weight, large stones. All other soils are rated as an improbable source. Coarse fragments of soft bedrock, such as shale and siltstone, are not considered to be sand and gravel.

Topsoil is used to cover an area so that vegetation can be established and maintained. The upper 40 inches of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area.

Plant growth is affected by toxic material and by such properties as soil reaction, available water capacity, and fertility. The ease of excavating, loading, and spreading is affected by rock fragments, slope, a water table, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, a water table, rock fragments, bedrock, and toxic material.

Soils rated *good* have friable, loamy material to a depth of at least 40 inches. They are free of stones and cobbles, have little or no gravel, and have slopes of less than 8 percent. They are low in content of soluble salts, are naturally fertile or respond well to fertilizer, and are not so wet that excavation is difficult.

Soils rated *fair* are sandy soils, loamy soils that have a relatively high content of clay, soils that have only 20 to 40 inches of suitable material, soils that have an appreciable amount of gravel, stones, or soluble salts, or soils that have slopes of 8 to 15 percent. The soils are not so wet that excavation is difficult.

Soils rated *poor* are very sandy or clayey, have less than 20 inches of suitable material, have a large amount of gravel, stones, or soluble salts, have slopes of more than 15 percent, or have a seasonal high water table at or near the surface.

The surface layer of most soils is generally preferred for topsoil because of its organic matter content. Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

Water Management

Table 13 gives information on the soil properties and site features that affect water management. The degree and kind of soil limitations are given for pond reservoir areas and for embankments, dikes, and levees. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and are easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increase in construction costs, and possibly increased maintenance are required.

This table also gives for each soil the restrictive features that affect drainage, irrigation, terraces and diversions, and grassed waterways.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the permeability of the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

Embankments, dikes, and levees are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against overflow. In this table, the soils are rated as a source of material for embankment fill. The ratings apply to the soil material below the surface layer to a depth of about 5 feet. It is assumed that soil layers will be uniformly mixed and compacted during construction.

The ratings do not indicate the ability of the natural soil to support an embankment. Soil properties to a depth even greater than the height of the embankment can affect performance and safety of the embankment. Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of stones or boulders, organic matter, or salts or sodium. A high water table affects the amount of usable material. It also affects trafficability.

Drainage is the removal of excess surface and subsurface water from the soil. How easily and effectively the soil is drained depends on the depth to bedrock, to a cemented pan, or to other layers that affect the rate of water movement; permeability; depth to a high water table or depth of standing water if the soil is subject to ponding; slope; susceptibility to flooding; subsidence of organic layers; and the potential for frost action. Excavating and grading and the stability of ditchbanks are affected by depth to bedrock or to a cemented pan, large stones, slope, and the hazard of cutbanks caving. The productivity of the soil after drainage is adversely affected by extreme acidity or by toxic substances in the root zone, such as salts, sodium, or sulfur. Availability of drainage outlets is not considered in the ratings.

Irrigation is the controlled application of water to supplement rainfall and support plant growth. The design and management of an irrigation system are affected by depth to the water table, the need for drainage, flooding, available water capacity, intake rate, permeability, erosion hazard, and slope. The construction of a system is affected by large stones and depth to bedrock or to a cemented pan. The performance of a system is affected by the depth of the root zone, the amount of salts or sodium, and soil reaction.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to control erosion and conserve moisture by intercepting runoff. Slope, wetness, large stones, and depth to bedrock or to a cemented pan affect the construction of terraces and diversions. A restricted rooting depth, a severe hazard of soil blowing or water erosion, an excessively coarse texture, and restricted permeability adversely affect maintenance.

Grassed waterways are natural or constructed channels, generally broad and shallow, that conduct surface water to outlets at a nonerosive velocity. Large stones, wetness, slope, and depth to bedrock or to a cemented pan affect the construction of grassed waterways. A hazard of soil blowing, low available water capacity, restricted rooting depth, toxic substances such as salts or sodium, and restricted permeability adversely affect the growth and maintenance of the grass after construction.

Soil Properties

Data relating to soil properties are collected during the course of the soil survey. The data and the estimates of soil and water features, listed in tables, are explained on the following pages.

Soil properties are determined by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures are followed. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps. Samples are taken from some typical profiles and tested in the laboratory to determine grain-size distribution, plasticity, and compaction characteristics. These results are reported in table 17.

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help to characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits, the engineering classification, and the physical and chemical properties of the major layers of each soil. Pertinent soil and water features also are given.

Engineering Index Properties

Table 14 gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 5 or 6 feet.

Depth to the upper and lower boundaries of each layer is indicated. The range in depth and information on other properties of each layer are given for each soil series under the heading "Soil Series and Their Morphology."

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter. "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is as much as about 15 percent, an appropriate modifier is added, for example, "gravelly." Textural terms are defined in the "Glossary."

Classification of the soils is determined according to the Unified soil classification system *(2)* and the system adopted by the American Association of State Highway and Transportation Officials *(1)*.

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as PT. Soils exhibiting engineering properties of two groups can have a dual classification, for example, CL-ML.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement, the suitability of a soil as subgrade material can be indicated by a group index number. Group index numbers range from 0 for the best subgrade material to 20 or higher for the poorest. The AASHTO classification for soils tested, with group index numbers in parentheses, is given in table 17.

Rock fragments 3 to 10 inches in diameter are indicated as a percentage of the total soil on a dry-

weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an ovendry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination.

The estimates of grain-size distribution, liquid limit, and plasticity index are rounded to the nearest 5 percent. Thus, if the ranges of gradation and Atterberg limits extend a marginal amount (1 or 2 percentage points) across classification boundaries, the classification in the marginal zone is omitted in the table.

Physical and Chemical Properties

Table 15 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Permeability refers to the ability of a soil to transmit water or air. The estimates indicate the rate of downward movement of water when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems and septic tank absorption fields.

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each major soil layer. The capacity varies, depending on soil properties that affect the retention of water and the depth of the root zone. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Soil reaction is a measure of acidity or alkalinity and is expressed as a range in pH values. The range in pH of each major horizon is based on many field tests. For many soils, values have been verified by laboratory analyses. Soil reaction is important in selecting crops and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

Salinity is a measure of soluble salts in the soil at saturation. It is expressed as the electrical conductivity of the saturation extract, in millimhos per centimeter at 25 degrees C. Estimates are based on field and laboratory measurements at representative sites of nonirrigated soils. The salinity of irrigated soils is affected by the quality of the irrigation water and by the frequency of water application. Hence, the salinity of soils in individual fields can differ greatly from the value given in the table. Salinity affects the suitability of a soil for crop production, the stability of soil if used as construction material, and the potential of the soil to corrode metal and concrete.

Shrink-swell potential is the potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on measurements of similar soils.

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to buildings, roads, and other structures. Special design is often needed.

Shrink-swell potential classes are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The classes are *low*, a change of less than 3 percent; *moderate*, 3 to 6 percent; and *high*, more than 6 percent. *Very high*, greater than 9 percent, is sometimes used.

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter (up to 4 percent) and on soil structure and permeability. Values of K range from 0.05 to 0.69. The higher the value, the more susceptible the soil is to sheet and rill erosion by water.

Erosion factor T is an estimate of the maximum average annual rate of soil erosion by wind or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

Wind erodibility groups are made up of soils that have similar properties affecting their resistance to soil blowing in cultivated areas. The groups indicate the susceptibility to soil blowing. Soils are grouped according to the following distinctions:

1. Coarse sands, sands, fine sands, and very fine sands. These soils are generally not suitable for crops. They are extremely erodible, and vegetation is difficult to establish.
2. Loamy coarse sands, loamy sands, loamy fine sands, loamy very fine sands, and sapric soil material. These soils are very highly erodible. Crops can be grown if intensive measures to control soil blowing are used.
3. Coarse sandy loams, sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible. Crops can be grown if intensive measures to control soil blowing are used.

4L. Calcareous loams, silt loams, clay loams, and silty clay loams. These soils are erodible. Crops can be grown if intensive measures to control soil blowing are used.

4. Clays, silty clays, noncalcareous clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible. Crops can be grown if measures to control soil blowing are used.
5. Noncalcareous loams and silt loams that are less than 20 percent clay and sandy clay loams, sandy clays, and hemic soil material. These soils are slightly erodible. Crops can be grown if measures to control soil blowing are used.
6. Noncalcareous loams and silt loams that are more than 20 percent clay and noncalcareous clay loams that are less than 35 percent clay. These soils are very slightly erodible. Crops can be grown if ordinary measures to control soil blowing are used.
7. Silts, noncalcareous silty clay loams that are less than 35 percent clay, and fibric soil material. These soils are very slightly erodible. Crops can be grown if ordinary measures to control soil blowing are used.
8. Soils that are not subject to soil blowing because of coarse fragments on the surface or because of surface wetness.

Soil and Water Features

Table 16 gives estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are assigned to one of four groups. They are grouped according to the infiltration of water when the soils are thoroughly wet and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to two hydrologic groups in table 16, the first letter is for drained areas and the second is for undrained areas.

Flooding, the temporary inundation of an area, is caused by overflowing streams, by runoff from adjacent slopes, or by tides. Water standing for short periods after rainfall or snowmelt is not considered flooding, nor is water in swamps and marshes.

Table 16 gives the frequency and duration of flooding and the time of year when flooding is most likely.

Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions (the chance of flooding is nearly 0 percent to 5 percent in any year); *occasional* that it occurs infrequently under normal weather conditions (the chance of flooding is 5 to 50 percent in any year); and *frequent* that it occurs often under normal weather conditions (the chance of flooding is more than 50 percent in any year). Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, *long* if 7 days to 1 month, and *very long* if more than 1 month. Probable dates are expressed in months. About two-thirds to three-fourths of all flooding occurs during the stated period.

The information is based on evidence in the soil

profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and little or no horizon development.

Also considered are local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table (seasonal) is the highest level of a saturated zone in the soil in most years. The estimates are based mainly on the evidence of a saturated zone, namely grayish colors or mottles in the soil. Indicated in table 16 are depth to the seasonal high water table; the kind of water table—that is, perched or apparent; and the months of the year that the water table commonly is high. A water table that is seasonally high for less than 1 month is not indicated in table 16.

An *apparent* water table is a thick zone of free water in the soil. It is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil. A *perched* water table is water standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

Only saturated zones within a depth of about 6 feet are indicated. A plus sign preceding the range in depth indicates that the water table is above the surface of the soil. The first numeral in the range indicates how high the water rises above the surface. The second numeral indicates the depth below the surface.

Potential frost action is the likelihood of upward or lateral expansion of the soil caused by the formation of segregated ice lenses (frost heave) and the subsequent collapse of the soil and loss of strength on thawing. Frost action occurs when moisture moves into the freezing zone of the soil. Temperature, texture, density, permeability, content of organic matter, and depth to the water table are the most important factors considered in evaluating the potential for frost action. It is assumed that the soil is not insulated by vegetation or snow and is not artificially drained. Silty and highly structured, clayey soils that have a high water table in winter are the most susceptible to frost action. Well drained, very gravelly, or very sandy soils are the least susceptible. Frost heave and low soil strength during thawing cause damage mainly to pavements and other rigid structures.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors results in a severe hazard of corrosion. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than steel in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low*, *moderate*, or *high*, is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion is also expressed as *low*, *moderate*, or *high*. It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

Engineering Index Test Data

Table 17 shows laboratory test data for several pedons sampled at carefully selected sites in the survey area. The pedons are representative of the series described in the section "Soil Series and Their Morphology." The soil samples were tested by the North Dakota State Highway Department Laboratory.

The testing methods generally are those of the American Association of State Highway and Transportation Officials (AASHTO) or the American Society for Testing and Materials (ASTM).

The tests and methods are AASHTO classification—M 145 (AASHTO), D 3282 (ASTM); Unified classification—D 2487 (ASTM); Mechanical analysis—T 88 (AASHTO), D 422 (ASTM), D 2217 (ASTM); Liquid limit—T 89 (AASHTO), D 4318 (ASTM); Plasticity index—T 90 (AASHTO), D 4318 (ASTM); and Moisture density—T 99 (AASHTO), D 698 (ASTM).

Classification of the Soils

The system of soil classification used by the National Cooperative Soil Survey has six categories *(13)*. Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. Table 18 shows the classification of the soils in the survey area. The categories are defined in the following paragraphs.

ORDER. Eleven soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in *sol*. An example is Mollisol.

SUBORDER. Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Boroll (*Bor*, meaning cool, plus *oll*, from Mollisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Haploborolls (*Hapl*, meaning minimal horizonation, plus *boroll*, the suborder of the Mollisols that has a frigid temperature regime).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Udic* identifies the subgroup that has a Udic moisture regime. An example is Udic Haploborolls.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Generally, the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineral content, temperature regime, depth of the root zone, consistence, moisture equivalent, slope, and permanent cracks. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is fine-loamy, mixed Udic Haploborolls.

SERIES. The series consists of soils that have similar horizons in their profile. The horizons are similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile. The texture of the surface layer or of the substratum can differ within a series.

Soil Series and Their Morphology

In this section, each soil series recognized in the survey area is described. The descriptions are arranged in alphabetic order.

Characteristics of the soil and the material in which it formed are identified for each series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The detailed description of each soil horizon follows standards in the "Soil Survey Manual" *(15)*. Many of the technical terms used in the descriptions are defined in "Soil Taxonomy" *(13)*. Unless otherwise stated, colors in the descriptions are for moist soil. Following the pedon description is the range of important characteristics of the soils in the series.

The map units of each soil series are described in the section "Detailed Soil Map Units."

Arveson Series

The Arveson series consists of very deep, poorly drained, highly calcareous soils on outwash plains and lake plains. These soils formed in glaciofluvial and glaciolacustrine deposits. Permeability is moderately

rapid in the upper part of the profile and moderately slow in the lower part. Slope is 0 to 1 percent.

Typical pedon of Arveson loam, in an area of Colvin and Arveson, loamy substratum, soils, saline; 1,190 feet north and 710 feet west of the southeast corner of sec. 4, T. 147 N., R. 62 W.

A1—0 to 4 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine granular structure; hard and friable; sticky and plastic; many very fine and common fine roots; strong effervescence; moderately alkaline; clear smooth boundary.

A2—4 to 11 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; hard and friable; sticky and plastic; common very fine roots; discontinuous black (10YR 2/1) coatings on faces of peds; few fine salt flecks; strong effervescence; moderately alkaline; clear smooth boundary.

Bkg1—11 to 19 inches; gray (5Y 5/1) sandy clay loam, light gray (5Y 6/1) dry; weak medium prismatic structure; hard and friable; sticky and plastic; few very fine roots; lime disseminated throughout; violent effervescence; moderately alkaline; gradual smooth boundary.

Bkg2—19 to 26 inches; gray (5Y 5/1) sandy loam, light gray (5Y 6/1) dry; weak medium prismatic structure; soft and friable; slightly sticky and slightly plastic; lime disseminated throughout; violent effervescence; moderately alkaline; clear smooth boundary.

Cg1—26 to 41 inches; olive gray (5Y 5/2) loamy fine sand, light olive gray (5Y 6/2) dry; common medium prominent yellowish brown (10YR 5/6) mottles; massive; soft and very friable; nonsticky and nonplastic; strong effervescence; moderately alkaline; clear smooth boundary.

2Cg2—41 to 45 inches; olive gray (5Y 5/2) clay loam, light olive gray (5Y 6/2) dry; many medium prominent yellowish brown (10YR 5/8) and few fine prominent strong brown (7.5YR 4/6) mottles; massive; hard and friable; sticky and plastic; about 12 percent gravel; slight effervescence; slightly alkaline; clear smooth boundary.

2Cg3—45 to 60 inches; olive gray (5Y 5/2) clay loam, light olive gray (5Y 6/2) dry; few fine distinct olive brown (2.5Y 4/4) and prominent strong brown (7.5YR 4/6) mottles; massive; very hard and firm; sticky and plastic; about 10 percent gravel; slight effervescence; slightly alkaline.

The thickness of the mollic epipedon ranges from 7 to 16 inches. The depth to loamy fine sand or coarser sediments is 20 to 40 inches. The soils range from nonsaline to moderately saline. Depth to the 2Cg horizon is more than 40 inches.

The A horizon has hue of 10YR to 5Y. The Bkg horizon has hue of 2.5Y or 5Y, value of 3 to 7 (4 to 8 dry), and chroma of 1 or 2. It is sandy clay loam, sandy loam, or fine sandy loam. The Cg and 2Cg horizons have hue of 2.5Y or 5Y, value of 4 to 6 (5 to 7 dry), and chroma of 1 or 2. The Cg horizon ranges from loamy sand to fine sandy loam. Some pedons do not have a 2Cg horizon.

Arvilla Series

The Arvilla series consists of very deep, somewhat excessively drained soils on outwash plains and terraces. These soils formed in glaciofluvial deposits. Permeability is moderately rapid in the upper part of the profile and very rapid in the lower part. Slope ranges from 0 to 9 percent.

The Arvilla soils in this county have a sandy loam mollic epipedon that is slightly thicker than is definitive for the series. This difference, however, does not affect the use and management of the soils.

Typical pedon of Arvilla sandy loam, 0 to 6 percent slopes, 1,300 feet south and 300 feet east of the northwest corner of sec. 1, T. 147 N., R. 64 W.

Ap—0 to 11 inches; black (10YR 2/1) sandy loam, very dark gray (10YR 3/1) dry; weak fine granular structure; soft and very friable; nonsticky and nonplastic; common very fine roots; about 1 percent gravel; neutral; clear smooth boundary.

Bw—11 to 18 inches; dark brown (10YR 3/3) coarse sandy loam, brown (10YR 4/3) dry; weak medium prismatic structure; slightly hard and very friable; nonsticky and nonplastic; few very fine roots; about 5 percent gravel; neutral; clear smooth boundary.

2C1—18 to 30 inches; dark yellowish brown (10YR 4/4) gravelly coarse sand, yellowish brown (10YR 5/4) dry; single grain; loose; nonsticky and nonplastic; about 30 percent gravel; slight effervescence; slightly alkaline; gradual wavy boundary.

2C2—30 to 45 inches; dark brown (10YR 4/3) coarse sand, brown (10YR 5/3) dry; single grain; loose; nonsticky and nonplastic; about 5 percent gravel; slight effervescence; slightly alkaline; gradual wavy boundary.

2C3—45 to 60 inches; brown (10YR 5/3) sand, very pale brown (10YR 7/3) dry; single grain; loose; nonsticky and nonplastic; about 1 percent gravel; slight effervescence; slightly alkaline.

The depth to sand and gravel ranges from 14 to 25 inches. The A horizon has value of 2 or 3 (3 or 4 dry). The Bw horizon has hue of 2.5Y to 7.5YR, value of 2 to

4 (3 to 5 dry), and chroma of 1 to 3. It is sandy loam or coarse sandy loam. The content of gravel in the 2C horizon ranges from 5 to 35 percent.

Barnes Series

The Barnes series consists of very deep, well drained, moderately slowly permeable soils on till plains, mantled till plains, and moraines. These soils formed in glacial till and eolian material. Slope ranges from 0 to 25 percent.

Typical pedon of Barnes loam, in an area of Barnes-Svea loams, 3 to 6 percent slopes; 2,275 feet north and 600 feet east of the southwest corner of sec. 30, T. 145 N., R. 63 W.

Ap—0 to 9 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; slightly hard and friable; slightly sticky and slightly plastic; common very fine roots; about 1 percent gravel; neutral; abrupt smooth boundary.

Bw—9 to 20 inches; brown (10YR 4/3) loam, pale brown (10YR 6/3) dry; moderate fine prismatic structure parting to weak fine subangular blocky; hard and friable; sticky and plastic; few very fine roots; discontinuous dark brown (10YR 3/3) coatings on vertical faces of peds; about 1 percent gravel; slightly alkaline; clear smooth boundary.

Bk—20 to 29 inches; light olive brown (2.5Y 5/4) loam, pale yellow (2.5Y 7/4) dry; weak medium prismatic structure; slightly hard and friable; sticky and plastic; few very fine roots; about 5 percent gravel; few fine irregularly shaped soft masses of lime; violent effervescence; moderately alkaline; gradual smooth boundary.

BCk—29 to 43 inches; light olive brown (2.5Y 5/4) loam, light yellowish brown (2.5Y 6/4) dry; massive; hard and friable; slightly sticky and slightly plastic; about 5 percent gravel; few fine irregularly shaped soft masses of lime; strong effervescence; slightly alkaline; gradual smooth boundary.

C—43 to 60 inches; light olive brown (2.5Y 5/4) loam, light yellowish brown (2.5Y 6/4) dry; massive; hard and friable; slightly sticky and slightly plastic; about 10 percent gravel; slight effervescence; slightly alkaline.

The thickness of the mollic epipedon ranges from 7 to 16 inches. The A horizon has value of 2 or 3 (3 or 4 dry). It is loam or sandy loam. The Bw horizon has hue of 10YR or 2.5Y, value of 2 to 5 (4 to 6 dry), and chroma of 2 to 4. The Bk, BCk, and C horizons are loam or clay loam. The Bk and BCk horizons have hue of 10YR or 2.5Y, value of 4 to 6 (5 to 8 dry), and chroma of 2 to 4. The C horizon has value of 4 to 6 (5 to 7 dry) and chroma of 2 to 4.

Bearden Series

The Bearden series consists of very deep, somewhat poorly drained, highly calcareous soils on lake plains. These soils formed in glaciolacustrine deposits. Permeability is moderately slow in the upper part of the profile and rapid in the lower part. Slope is 0 to 1 percent.

Typical pedon of Bearden silty clay loam, sandy substratum, 1,700 feet east and 420 feet south of the northwest corner of sec. 1, T. 145 N., R. 65 W.

Ap—0 to 8 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; hard and friable; sticky and plastic; few fine and very fine roots; strong effervescence; moderately alkaline; abrupt smooth boundary.

ABk—8 to 11 inches; very dark gray (10YR 3/1) silty clay loam, gray (10YR 5/1) dry; weak medium subangular blocky structure; hard and friable; sticky and plastic; few fine and very fine roots; few fine irregularly shaped soft masses of lime; violent effervescence; moderately alkaline; clear wavy boundary.

Bk1—11 to 22 inches; gray (10YR 5/1) silty clay loam, light gray (10YR 7/1) dry; weak medium subangular blocky structure; hard and friable; sticky and plastic; few very fine roots; lime disseminated throughout; violent effervescence; moderately alkaline; clear wavy boundary.

Bk2—22 to 35 inches; light olive brown (2.5Y 5/4) silt loam, light yellowish brown (2.5Y 6/4) dry; many medium distinct light brownish gray (2.5Y 6/2) mottles; weak medium subangular blocky structure; hard and friable; slightly sticky and slightly plastic; lime disseminated throughout; violent effervescence; moderately alkaline; gradual wavy boundary.

C1—35 to 51 inches; light olive brown (2.5Y 5/4) silt loam, light yellowish brown (2.5Y 6/4) dry; common medium distinct light brownish gray (2.5Y 6/2) and few fine prominent dark yellowish brown (10YR 4/6) mottles; massive; hard and friable; slightly sticky and slightly plastic; slight effervescence; moderately alkaline; abrupt smooth boundary.

2C2—51 to 60 inches; light olive brown (2.5Y 5/4) sand, light yellowish brown (2.5Y 6/4) dry; few medium prominent gray (5Y 5/1) mottles; single grain; loose; nonsticky and nonplastic; slight effervescence; slightly alkaline.

The thickness of the mollic epipedon ranges from 7 to 20 inches. The A horizon has hue of 10YR or 2.5Y and value of 2 or 3 (3 to 5 dry). The Bk horizon has hue of 10YR to 5Y and value of 3 to 5 (5 to 7 dry). The C horizon has hue of 2.5Y or 5Y, value of 4 to 7 (5 to 8 dry), and chroma of 2 to 4. It is silt loam or silty clay loam. Depth to the 2C horizon, if it occurs, is more than 40 inches. Some pedons do not have a 2C horizon.

Buse Series

The Buse series consists of very deep, well drained, moderately slowly permeable soils on till plains and moraines. These soils formed in glacial till. Slope ranges from 3 to 35 percent.

Typical pedon of Buse loam, in an area of Barnes-Buse loams, 6 to 9 percent slopes; 1,200 feet west and 300 feet south of the northeast corner of sec. 24, T. 146 N., R. 64 W.

Ap—0 to 7 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; hard and friable; sticky and plastic; many very fine roots; about 5 percent gravel; strong effervescence; moderately alkaline; clear smooth boundary.

Bk—7 to 18 inches; light olive brown (2.5Y 5/4) loam, pale yellow (2.5Y 7/4) dry; weak fine subangular blocky structure; hard and friable; sticky and plastic; common very fine roots; about 3 percent gravel; common medium irregularly shaped soft masses of lime; violent effervescence; moderately alkaline; clear smooth boundary.

C—18 to 60 inches; light olive brown (2.5Y 5/4) loam, light yellowish brown (2.5Y 6/4) dry; massive; hard and friable; sticky and plastic; few very fine roots in the upper part; about 5 percent gravel; strong effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 7 to 10 inches. The A horizon has value of 2 or 3 (4 or 5 dry). The Bk horizon has hue of 10YR or 2.5Y, value of 4 to 6 (6 or 7 dry), and chroma of 2 to 4. The C horizon has hue of 10YR to 5Y, value of 4 to 6 (5 to 7 dry), and chroma of 2 to 5. The B and C horizons are loam or clay loam.

Cathay Series

The Cathay series consists of very deep, moderately well drained, moderately slowly permeable, sodic soils on till plains. These soils formed in glacial till. Slope ranges from 0 to 6 percent.

Typical pedon of Cathay loam, in an area of Cathay-Heimdal loams, 1 to 3 percent slopes; 1,075 feet north and 725 feet west of the southeast corner of sec. 28, T. 146 N., R. 67 W.

Ap—0 to 8 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure parting to weak fine granular; slightly hard and friable; slightly sticky and slightly plastic; many fine and very fine roots; slightly alkaline; clear smooth boundary.

Btn—8 to 18 inches; very dark grayish brown (10YR 3/2) clay loam, dark gray (10YR 4/1) dry; moderate fine prismatic structure parting to moderate fine angular blocky; very hard and firm; sticky and plastic; few fine and very fine roots along vertical faces of prisms; gray (10YR 5/1) coatings of silt and sand interfingering on sides of prisms; continuous very dark brown (10YR 2/2) clay films on faces of peds; slightly alkaline; clear smooth boundary.

Bk1—18 to 29 inches; light brownish gray (2.5Y 6/2) loam, light gray (2.5Y 7/2) dry; common fine distinct olive (5Y 5/3) mottles; weak fine prismatic structure parting to weak fine subangular blocky; slightly hard and friable; slightly sticky and slightly plastic; few very fine roots; about 2 percent gravel; lime disseminated throughout; violent effervescence; moderately alkaline; clear smooth boundary.

Bk2—29 to 40 inches; olive brown (2.5Y 4/4) loam, light olive brown (2.5Y 5/4) dry; few fine distinct gray (N 5/0) and light olive brown (2.5Y 5/6) mottles; weak fine prismatic structure parting to weak fine subangular blocky; hard and friable; slightly sticky and slightly plastic; few very fine roots; about 2 percent gravel; few fine irregularly shaped soft masses of lime; strong effervescence; moderately alkaline; clear smooth boundary.

C1—40 to 47 inches; olive brown (2.5Y 4/4) loam, light yellowish brown (2.5Y 6/4) dry; few fine distinct gray (N 5/0) and light olive brown (2.5Y 5/6) mottles; massive; hard and friable; slightly sticky and slightly plastic; few very fine roots; about 2 percent gravel; common fine irregularly shaped soft masses of lime; slight effervescence; moderately alkaline; gradual smooth boundary.

C2—47 to 60 inches; olive brown (2.5Y 4/4) loam, light yellowish brown (2.5Y 6/4) dry; few fine prominent yellowish red (5YR 5/8) and common medium distinct gray (N 5/0) mottles; massive; hard and friable; slightly sticky and slightly plastic; few black (N 2/0) accumulations of manganese oxide; about 5 percent gravel; few fine irregularly shaped soft masses of lime; slight effervescence; moderately alkaline.

The A horizon has value of 2 or 3 (3 to 5 dry). Some pedons have an E or BE horizon. The Btn horizon has

value of 3 or 4 (3 to 5 dry) and chroma of 1 to 4. It is loam or clay loam. The C horizon has hue of 2.5Y or 5Y, value of 3 to 5 (4 to 6 dry), and chroma of 3 or 4. It has pockets of silt or fine sand in some pedons.

Coe Series

The Coe series consists of very deep, excessively drained soils on valley side slopes and eskers. These soils formed in glaciofluvial deposits. Permeability is moderate in the upper part of the profile and very rapid in the lower part. Slope ranges from 9 to 35 percent.

Typical pedon of Coe loam, in an area of Coe-Heimdal loams, 9 to 35 percent slopes; 1,200 feet north and 180 feet west of the southeast corner of sec. 3, T. 146 N., R. 64 W.

A—0 to 5 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak medium granular structure; slightly hard and friable; slightly sticky and slightly plastic; many very fine roots; about 5 percent gravel; slightly alkaline; abrupt irregular boundary.

AC—5 to 10 inches; very dark gray (10YR 3/1) gravelly loam, gray (10YR 5/1) dry; weak medium prismatic structure parting to weak medium granular; slightly hard and friable; slightly sticky and slightly plastic; common very fine roots; about 20 percent gravel, of which 15 percent is shale; slight effervescence; moderately alkaline; clear wavy boundary.

C1—10 to 20 inches; dark grayish brown (2.5Y 4/2) very gravelly sand, light brownish gray (2.5Y 6/2) dry; single grain; loose; nonsticky and nonplastic; few very fine roots; about 50 percent gravel, of which about 80 percent is shale; slight effervescence; moderately alkaline; clear wavy boundary.

C2—20 to 26 inches; grayish brown (2.5Y 5/2) very gravelly sand, light gray (2.5Y 7/2) dry; single grain; loose; nonsticky and nonplastic; few very fine roots; about 40 percent gravel, of which about 40 percent is shale; slight effervescence; slightly alkaline; clear wavy boundary.

C3—26 to 60 inches; grayish brown (2.5Y 5/2) gravelly coarse sand, light brownish gray (2.5Y 6/2) dry; single grain; loose; nonsticky and nonplastic; about 25 percent shale gravel; slight effervescence; slightly alkaline.

The depth to sand and gravel ranges from 6 to 14 inches. The A horizon has value of 2 or 3 (3 to 5 dry). The C horizon has hue of 2.5Y or 5Y, or it is neutral in hue. It has value of 4 to 6 (4 to 7 dry) and chroma of 0 to 3. The content of coarse fragments in this horizon is 35 to 80 percent, and the content of shale is more than 20 percent.

Colvin Series

The Colvin series consists of very deep, poorly drained and very poorly drained, moderately slowly permeable, highly calcareous soils on lake plains and flood plains. These soils formed in glaciolacustrine deposits and alluvium. Slope is 0 to 1 percent.

Typical pedon of Colvin silt loam, in an area of Colvin and Arveson, loamy substratum, soils, saline; 2,200 feet south and 280 feet west of the northeast corner of sec. 5, T. 147 N., R. 62 W.

Az—0 to 7 inches; black (10YR 2/1) silt loam, dark gray (5Y 4/1) dry; weak fine subangular blocky structure; slightly hard and friable; slightly sticky and plastic; common very fine roots; common fine flecks of salts; strong effervescence; moderately alkaline; clear wavy boundary.

Bkz—7 to 12 inches; dark gray (10YR 4/1) silty clay loam, gray (10YR 5/1) dry; weak medium subangular blocky structure; hard and friable; sticky and plastic; common very fine roots; few fine flecks of salts; lime disseminated throughout; violent effervescence; moderately alkaline; clear wavy boundary.

Bky—12 to 31 inches; grayish brown (2.5Y 5/2) silty clay loam, light brownish gray (2.5Y 6/2) dry; weak fine subangular blocky structure; hard and friable; sticky and plastic; common very fine roots; few nests of gypsum crystals; lime disseminated throughout; violent effervescence; slightly alkaline; clear irregular boundary.

Bkg—31 to 36 inches; light gray (5Y 7/1) and olive (5Y 5/3) silt loam, pale olive (5Y 6/3) dry; few fine prominent yellowish brown (10YR 5/4) mottles; massive; very hard and firm; slightly sticky and slightly plastic; lime disseminated throughout; violent effervescence; moderately alkaline; gradual wavy boundary.

Cg—36 to 60 inches; gray (5Y 5/1) silt loam, light gray (5Y 7/1) dry; many medium prominent light olive brown (2.5Y 5/4) and dark brown (7.5YR 4/4) mottles; massive; very hard and firm; slightly sticky and slightly plastic; slight effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 7 to 20 inches. The soils range from nonsaline to moderately saline.

The A horizon has hue of 10YR to 5Y and value of 2 or 3 (3 or 4 dry). The Bk horizon has value of 3 to 7 (5 to 8 dry). The C horizon has hue of 2.5Y or 5Y, value of 3 to 6 (5 to 7 dry), and chroma of 1 to 4. It is silt loam or silty clay loam.

Divide Series

The Divide series consists of very deep, somewhat poorly drained, highly calcareous soils on outwash plains. These soils formed in glaciofluvial deposits. Permeability is moderate in the upper part of the profile and very rapid in the lower part. Slope ranges from 0 to 3 percent.

Typical pedon of Divide loam, 0 to 3 percent slopes, 1,200 feet west and 1,100 feet south of the northeast corner of sec. 31, T. 146 N., R. 65 W.

Ap—0 to 10 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; slightly hard and friable; slightly sticky and slightly plastic; few very fine roots; about 5 percent gravel; slight effervescence; moderately alkaline; abrupt smooth boundary.

Bk1—10 to 18 inches; gray (10YR 6/1) loam, light gray (10YR 7/1) dry; weak medium subangular blocky structure parting to weak fine subangular blocky; slightly hard and friable; sticky and slightly plastic; discontinuous dark gray (10YR 4/1) coatings on faces of peds; about 5 percent gravel; lime disseminated throughout; violent effervescence; moderately alkaline; clear smooth boundary.

Bk2—18 to 26 inches; light olive brown (2.5Y 5/4) loam, light yellowish brown (2.5Y 6/4) dry; common fine faint light brownish gray (2.5Y 6/2) and few fine distinct yellowish brown (10YR 5/6) mottles; weak medium subangular blocky structure parting to weak fine subangular blocky; slightly hard and friable; slightly sticky and slightly plastic; about 5 percent gravel; lime disseminated throughout; violent effervescence; slightly alkaline; gradual smooth boundary.

2BC—26 to 30 inches; light olive brown (2.5Y 5/4) sandy loam, light yellowish brown (2.5Y 6/4) dry; few fine faint light brownish gray (2.5Y 6/2) and few fine distinct yellowish brown (10YR 5/6) mottles; weak fine subangular blocky structure; slightly hard and very friable; slightly sticky and slightly plastic; about 5 percent gravel; very slight effervescence; slightly alkaline; clear smooth boundary.

2C—30 to 60 inches; light olive brown (2.5Y 5/4) and light brownish gray (2.5Y 6/2) sand, light yellowish brown (2.5Y 6/4) and light gray (2.5Y 7/2) dry; single grain; loose; nonsticky and nonplastic; slightly alkaline.

The thickness of the mollic epipedon ranges from 7 to 16 inches. Depth to the 2C horizon ranges from 20 to 40 inches.

The A horizon has hue of 10YR or 2.5Y and value of 2 or 3 (3 to 5 dry). The Bk horizon has hue of 10YR to 5Y and value of 4 to 6 (5 to 7 dry). It is loam, clay loam, or sandy clay loam. The 2C horizon has hue of 2.5Y or 5Y and value of 4 or 5 (5 to 7 dry). It ranges from sand to gravelly coarse sand.

Embden Series

The Embden series consists of very deep, moderately well drained, moderately rapidly permeable soils on outwash plains and lake plains. These soils formed in glaciofluvial and glaciolacustrine deposits. Slope ranges from 0 to 6 percent.

Typical pedon of Embden fine sandy loam, 0 to 6 percent slopes, 580 feet east and 150 feet north of the southwest corner of sec. 10, T. 147 N., R. 62 W.

Ap—0 to 7 inches; black (10YR 2/1) fine sandy loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; slightly hard and friable; slightly sticky and slightly plastic; common very fine roots; neutral; abrupt smooth boundary.

A—7 to 17 inches; black (10YR 2/1) fine sandy loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; slightly hard and friable; slightly sticky and slightly plastic; common very fine roots; neutral; gradual smooth boundary.

Bw1—17 to 29 inches; very dark gray (10YR 3/1) fine sandy loam, dark gray (10YR 4/1) dry; weak fine prismatic structure parting to weak fine subangular blocky; slightly hard and friable; slightly sticky and slightly plastic; few very fine roots; slightly alkaline; gradual smooth boundary.

Bw2—29 to 40 inches; dark grayish brown (2.5Y 4/2) fine sandy loam, grayish brown (2.5Y 5/2) dry; weak fine prismatic structure parting to weak fine subangular blocky; slightly hard and very friable; slightly sticky and slightly plastic; few very fine roots; slightly alkaline; gradual smooth boundary.

C—40 to 60 inches; light olive brown (2.5Y 5/4) fine sand, light yellowish brown (2.5Y 6/4) dry; common fine distinct dark yellowish brown (10YR 3/4) mottles; single grain; loose; nonsticky and nonplastic; slight effervescence; slightly alkaline.

The thickness of the mollic epipedon ranges from 16 to 35 inches. The depth to carbonates ranges from 20 to 60 inches.

The A horizon has value of 2 or 3 (3 or 4 dry). The Bw horizon has value of 2 to 4 (3 to 5 dry) and chroma of 1 to 3. It is fine sandy loam or sandy loam. The C horizon has hue of 2.5Y, or it is neutral in hue. It has value of 4 to 6 (5 to 7 dry) and chroma of 0 to 4. It ranges from fine sand to fine sandy loam.

Emrick Series

The Emrick series consists of very deep, moderately well drained, moderately permeable soils on till plains. These soils formed in glacial till. Slope ranges from 0 to 6 percent.

Typical pedon of Emrick loam, in an area of Heimdal-Emrick loams, 0 to 3 percent slopes; 2,375 feet north and 1,075 feet west of the southeast corner of sec. 5, T. 146 N., R. 67 W.

Ap—0 to 8 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; slightly hard and friable; slightly sticky and slightly plastic; slightly alkaline; abrupt smooth boundary.

A—8 to 16 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; slightly hard and friable; slightly sticky and slightly plastic; slightly alkaline; gradual smooth boundary.

Bw—16 to 22 inches; very dark grayish brown (10YR 3/2) loam, dark grayish brown (10YR 4/2) dry; weak medium prismatic structure; slightly hard and friable; slightly sticky and slightly plastic; discontinuous very dark gray (10YR 3/1) coatings on faces of peds; slightly alkaline; clear smooth boundary.

Bk—22 to 43 inches; olive brown (2.5Y 4/4) loam, light olive brown (2.5Y 5/4) dry; weak medium prismatic structure; slightly hard and friable; slightly sticky and slightly plastic; about 2 percent gravel; common fine irregularly shaped soft masses of lime; violent effervescence; slightly alkaline; gradual smooth boundary.

C—43 to 60 inches; olive brown (2.5Y 4/4) loam, light yellowish brown (2.5Y 6/4) dry; few fine distinct grayish brown (2.5Y 5/2) mottles; massive; hard and friable; slightly sticky and slightly plastic; about 2 percent gravel; strong effervescence; slightly alkaline.

The thickness of the mollic epipedon ranges from 16 to 40 inches. The A horizon has value of 2 or 3 (3 or 4 dry). The Bw horizon has hue of 10YR or 2.5Y, value of 3 or 4 (4 or 5 dry), and chroma of 2 or 3. The Bk and C horizons have value of 4 or 5 and chroma of 2 to 4. In some pedons the B and C horizons have thin layers of sandy loam.

Esmond Series

The Esmond series consists of very deep, well drained, moderately permeable soils on till plains, moraines, and valley side slopes. These soils formed in glacial till. Slope ranges from 3 to 35 percent.

Typical pedon of Esmond loam, in an area of Heimdal-Esmond loams, 15 to 35 percent slopes; 2,190 feet east and 70 feet north of the southwest corner of sec. 11, T. 147 N., R. 62 W.

A—0 to 7 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; slightly hard and friable; slightly sticky and slightly plastic; many fine and very fine roots; about 3 percent gravel; strong effervescence; slightly alkaline; clear smooth boundary.

Bk—7 to 11 inches; dark grayish brown (2.5Y 4/2) loam, grayish brown (2.5Y 5/2) dry; weak fine subangular blocky structure; slightly hard and friable; slightly sticky and slightly plastic; many very fine roots; lime disseminated throughout; violent effervescence; moderately alkaline; clear smooth boundary.

C—11 to 60 inches; olive brown (2.5Y 4/4) loam, light olive brown (2.5Y 5/4) dry; massive; slightly hard and friable; slightly sticky and slightly plastic; few very fine roots in the upper part; about 3 percent gravel; strong effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 7 to 10 inches. Some pedons contain pockets of sand, fine sand, silt loam, or gravel.

The A horizon has value of 2 or 3 (3 to 5 dry). The Bk horizon has hue of 10YR or 2.5Y, value of 4 to 6 (5 to 7 dry), and chroma of 2 to 4. The C horizon has value of 4 or 5 (5 to 7 dry) and chroma of 2 to 4.

Fram Series

The Fram series consists of very deep, somewhat poorly drained, moderately permeable, highly calcareous soils on till plains. These soils formed in glacial till. Slope ranges from 0 to 3 percent.

Typical pedon of Fram loam, in an area of Fram-Wyard loams, 0 to 3 percent slopes; 1,775 feet north and 525 feet west of the southeast corner of sec. 30, T. 146 N., R. 65 W.

Ap—0 to 8 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; slightly hard and friable; slightly sticky and slightly plastic; common fine roots; about 5 percent gravel; strong effervescence; moderately alkaline; abrupt smooth boundary.

Bk1—8 to 11 inches; light brownish gray (2.5Y 6/2) loam, white (10YR 8/1) dry; common fine faint light yellowish brown (2.5Y 6/4) mottles; weak fine prismatic structure parting to weak fine subangular blocky; slightly hard and friable; slightly sticky and slightly plastic; few fine roots; about 5 percent gravel; lime disseminated throughout; violent

effervescence; moderately alkaline; clear smooth boundary.

Bk2—11 to 23 inches; light olive brown (2.5Y 5/4) and grayish brown (2.5Y 5/2) loam, pale yellow (2.5Y 7/4) and light gray (2.5Y 7/2) dry; weak fine prismatic structure parting to weak fine subangular blocky; slightly hard and friable; slightly sticky and slightly plastic; few fine roots; about 5 percent gravel; few fine irregularly shaped soft masses of lime; strong effervescence; slightly alkaline; clear smooth boundary.

C—23 to 60 inches; olive brown (2.5Y 4/4) loam, light yellowish brown (2.5Y 6/4) dry; common fine distinct gray (N 5/0) mottles; massive; hard and friable; slightly sticky and slightly plastic; few very fine roots; about 5 percent gravel; slight effervescence; slightly alkaline.

The thickness of the mollic epipedon ranges from 7 to 16 inches. The A horizon has value of 2 or 3 (3 to 5 dry). The Bk horizon has hue of 2.5Y or 10YR, value of 4 to 6 (6 to 8 dry), and chroma of 1 to 4. The C horizon has value of 4 or 5 (6 or 7 dry) and chroma of 2 to 4. The Bk and C horizons are loam or fine sandy loam.

Glyndon Series

The Glyndon series consists of very deep, somewhat poorly drained, moderately permeable, highly calcareous soils on lake plains. These soils formed in glaciolacustrine deposits. Slope ranges from 0 to 2 percent.

Typical pedon of Glyndon loam, 0 to 2 percent slopes, 1,510 feet east and 610 feet south of the northwest corner of sec. 4, T. 147 N., R. 62 W.

Ap—0 to 7 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; hard and friable; sticky and plastic; common very fine roots; slight effervescence; slightly alkaline; abrupt smooth boundary.

A—7 to 13 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; hard and friable; sticky and plastic; few very fine roots; slight effervescence; slightly alkaline; clear smooth boundary.

Bk1—13 to 20 inches; dark grayish brown (10YR 4/2) silt loam, gray (10YR 6/1) dry; weak medium prismatic structure parting to weak fine subangular blocky; hard and friable; slightly sticky and slightly plastic; few very fine roots; lime disseminated throughout; violent effervescence; moderately alkaline; clear smooth boundary.

Bk2—20 to 27 inches; light brownish gray (2.5Y 6/2) silt loam, white (10YR 8/1) dry; weak medium prismatic structure parting to weak fine subangular blocky; hard and friable; slightly sticky and slightly plastic; few very fine roots; lime disseminated throughout; violent effervescence; moderately alkaline; clear smooth boundary.

Bk3—27 to 33 inches; light yellowish brown (2.5Y 6/4) silt loam, pale yellow (2.5Y 7/4) dry; weak medium prismatic structure parting to weak fine subangular blocky; hard and friable; slightly sticky and slightly plastic; few very fine roots; lime disseminated throughout; violent effervescence; moderately alkaline; gradual smooth boundary.

C1—33 to 43 inches; light olive brown (2.5Y 5/4) silt loam, light yellowish brown (2.5Y 6/4) dry; common fine distinct olive gray (5Y 5/2) and prominent strong brown (7.5YR 4/6) mottles; massive; hard and friable; slightly sticky and slightly plastic; strong effervescence; slightly alkaline; gradual smooth boundary.

C2—43 to 60 inches; light yellowish brown (2.5Y 6/4) silt loam, pale yellow (2.5Y 7/4) dry; common fine prominent strong brown (7.5YR 4/6) and distinct light olive gray (5Y 6/2) mottles; massive; slightly hard and friable; nonsticky and nonplastic; strong effervescence; slightly alkaline.

The thickness of the mollic epipedon ranges from 7 to 16 inches. The A horizon has value of 2 or 3 (3 or 4 dry). The Bk horizon has hue of 10YR to 5Y, value of 4 to 7 (5 to 8 dry), and chroma of 1 to 4. It is silt loam or very fine sandy loam. The C horizon has hue of 2.5Y or 5Y, value of 4 to 6 (5 to 7 dry), and chroma of 2 to 4. It is silt loam, very fine sandy loam, or loamy very fine sand.

Hamerly Series

The Hamerly series consists of very deep, somewhat poorly drained, moderately slowly permeable, highly calcareous soils on till plains. These soils formed in glacial till. Slope ranges from 0 to 3 percent.

Typical pedon of Hamerly loam, in an area of Hamerly-Wyard loams, 0 to 3 percent slopes; 1,450 feet north and 450 feet west of the southeast corner of sec. 32, T. 146 N., R. 62 W.

Ap—0 to 9 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak fine granular structure; slightly hard and very friable; slightly sticky and slightly plastic; common fine and very fine roots; about 2 percent gravel; strong effervescence; moderately alkaline; gradual wavy boundary.

Bk1—9 to 19 inches; dark grayish brown (2.5Y 4/2) loam, light brownish gray (2.5Y 6/2) dry; weak medium prismatic structure; slightly hard and very

friable; slightly sticky and slightly plastic; few fine and very fine roots; about 2 percent gravel; lime disseminated throughout; violent effervescence; moderately alkaline; gradual wavy boundary.

Bk2—19 to 30 inches; light olive brown (2.5Y 5/4) loam, light gray (2.5Y 7/2) dry; weak medium subangular blocky structure; slightly hard and friable; slightly sticky and slightly plastic; few very fine roots; about 2 percent gravel; lime disseminated throughout; violent effervescence; moderately alkaline; gradual wavy boundary.

C1—30 to 55 inches; light olive brown (2.5Y 5/4) loam, pale yellow (2.5Y 7/4) dry; massive; hard and friable; slightly sticky and slightly plastic; about 3 percent gravel; few fine irregularly shaped soft masses of lime; strong effervescence; slightly alkaline; gradual wavy boundary.

C2—55 to 60 inches; light olive brown (2.5Y 5/4) loam, pale yellow (2.5Y 7/4) dry; few fine distinct light brownish gray (2.5Y 6/2) mottles; massive; hard and friable; slightly sticky and slightly plastic; about 3 percent gravel; strong effervescence; slightly alkaline.

The thickness of the mollic epipedon ranges from 7 to 16 inches. The soils range from nonsaline to moderately saline.

The A horizon has hue of 10YR or 2.5Y and value of 2 or 3 (3 or 4 dry). Some pedons have an ABk horizon, which is 3 to 5 inches thick. The Bk horizon has hue of 10YR to 5Y, value of 3 to 6 (4 to 8 dry), and chroma of 1 to 4. The C horizon has hue of 10YR to 5Y, value of 4 to 6 (5 to 7 dry), and chroma of 2 to 4. The Bk and C horizons are loam or clay loam. They have nests of gypsum in some pedons.

Hecla Series

The Hecla series consists of very deep, moderately well drained soils on outwash plains and lake plains. These soils formed in glaciofluvial and glaciolacustrine deposits. Permeability is rapid throughout, or it is rapid in the upper part of the profile and moderate in the lower part. Slope ranges from 0 to 3 percent.

Typical pedon of Hecla fine sandy loam, loamy substratum, 0 to 3 percent slopes, 480 feet east and 330 feet north of the southwest corner of sec. 4, T. 147 N., R. 62 W.

A1—0 to 12 inches; black (10YR 2/1) fine sandy loam, very dark gray (10YR 3/1) dry; weak fine granular structure; soft and very friable; nonsticky and nonplastic; many very fine roots; neutral; gradual smooth boundary.

A2—12 to 23 inches; very dark brown (10YR 2/2) loamy fine sand, very dark grayish brown (10YR 3/2) dry; weak medium prismatic structure parting to weak fine subangular blocky; soft and very friable; nonsticky and nonplastic; common very fine roots; continuous black (10YR 2/1) coatings on faces of peds; neutral; gradual smooth boundary.

AC—23 to 38 inches; very dark grayish brown (10YR 3/2) loamy fine sand, grayish brown (10YR 5/2) dry; few fine faint very dark brown (10YR 2/2) mottles; weak medium prismatic structure parting to weak fine subangular blocky; soft and very friable; nonsticky and nonplastic; few very fine roots; slightly alkaline; gradual smooth boundary.

C1—38 to 51 inches; olive (5Y 5/3) loamy fine sand, pale olive (5Y 6/3) dry; few fine faint olive gray (5Y 5/2) and prominent very dark grayish brown (10YR 3/2) mottles; massive; soft and very friable; nonsticky and nonplastic; few very fine roots; slight effervescence; moderately alkaline; clear smooth boundary.

2C2—51 to 60 inches; olive gray (5Y 5/2) clay loam, light olive gray (5Y 6/2) dry; many fine distinct olive (5Y 5/4) mottles; massive; hard and friable; sticky and plastic; few fine irregularly shaped soft masses of lime; strong effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 10 to 20 inches. The depth to carbonates ranges from 20 to more than 60 inches.

The A horizon has value of 2 or 3 (3 or 4 dry). The AC horizon has value of 2 or 3 (3 to 5 dry) and chroma of 1 or 2. The C horizon has hue of 10YR to 5Y, value of 3 to 5 (4 to 7 dry), and chroma of 2 to 4. It is loamy fine sand or fine sand. Some pedons do not have a loamy substratum.

Heimdal Series

The Heimdal series consists of very deep, well drained, moderately permeable soils on till plains, moraines, and valley side slopes. These soils formed in glacial till. Slope ranges from 0 to 25 percent.

Typical pedon of Heimdal loam, in an area of Heimdal-Emrick loams, 3 to 6 percent slopes; 1,500 feet north and 300 feet west of the southeast corner of sec. 22, T. 147 N., R. 64 W.

Ap—0 to 7 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak medium granular structure; slightly hard and friable; slightly sticky and slightly plastic; common fine and very fine roots; neutral; abrupt smooth boundary.

Bw—7 to 14 inches; dark brown (10YR 3/3) loam, brown (10YR 4/3) dry; moderate medium subangular blocky structure; slightly hard and

friable; slightly sticky and slightly plastic; common very fine roots; neutral; abrupt wavy boundary.

Bk—14 to 30 inches; light olive brown (2.5Y 5/4) loam, light yellowish brown (2.5Y 6/4) dry; weak medium subangular blocky structure; hard and friable; slightly sticky and slightly plastic; few very fine roots; about 5 percent gravel; few fine irregularly shaped soft masses of lime; strong effervescence; moderately alkaline; gradual wavy boundary.

C—30 to 60 inches; olive brown (2.5Y 4/4) loam, light olive brown (2.5Y 5/4) dry; massive; hard and friable; slightly sticky and slightly plastic; about 5 percent gravel; slight effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 7 to 16 inches. The A horizon has value of 2 or 3 (3 or 4 dry). The Bw horizon has value of 2 to 5 (4 to 6 dry) and chroma of 2 to 4. The Bk and C horizons have value of 4 or 5 (5 to 7 dry) and chroma of 2 to 4. The C horizon has thin layers of sandy loam in some pedons.

Kratka Series

The Kratka series consists of very deep, poorly drained soils on lake plains and mantled till plains. These soils formed in glaciolacustrine deposits, eolian material, and glacial till. Permeability is moderately rapid in the upper part of the profile and moderately slow in the lower part. Slope is 0 to 1 percent.

Typical pedon of Kratka fine sandy loam, 2,080 feet west and 210 feet south of the northeast corner of sec. 20, T. 146 N., R. 62 W.

Ap—0 to 8 inches; black (10YR 2/1) fine sandy loam, dark gray (10YR 4/1) dry; weak fine granular structure; slightly hard and friable; slightly sticky and nonplastic; few very fine roots; slightly alkaline; abrupt smooth boundary.

Bg1—8 to 28 inches; grayish brown (2.5Y 5/2) fine sand, light brownish gray (2.5Y 6/2) dry; many medium prominent yellowish brown (10YR 5/6) mottles; weak medium subangular blocky structure; very soft and very friable; nonsticky and nonplastic; few very fine roots; slightly alkaline; clear smooth boundary.

Bg2—28 to 32 inches; dark grayish brown (2.5Y 4/2) loamy fine sand, grayish brown (2.5Y 5/2) dry; few fine prominent yellowish brown (10YR 5/6) mottles; weak medium subangular blocky structure; soft and very friable; nonsticky and nonplastic; slightly alkaline; gradual irregular boundary.

2Bkg—32 to 45 inches; light gray (5Y 7/2) silt loam, white (5Y 8/1) dry; massive; hard and firm; slightly sticky and slightly plastic; about 1 percent gravel; lime disseminated throughout; violent effervescence; moderately alkaline; clear wavy boundary.

2Cg—45 to 60 inches; olive gray (5Y 5/2) silty clay loam, light gray (5Y 7/2) dry; many medium prominent yellowish brown (10YR 5/6) mottles; massive; hard and firm; slightly sticky and slightly plastic; about 5 percent gravel; few fine irregularly shaped soft masses of lime; strong effervescence; slightly alkaline.

The thickness of the mollic epipedon ranges from 8 to 18 inches. The depth to loam, clay loam, silt loam, or silty clay loam ranges from 20 to 40 inches.

The A horizon has hue of 10YR or 2.5Y, or it is neutral in hue. It has value of 2 or 3 (3 or 4 dry) and chroma of 0 to 2. In some pedons mottles are in the lower part of the A horizon. The Bg horizon has hue of 10YR or 2.5Y, value of 4 to 6 (5 to 7 dry), and chroma of 1 or 2. It is loamy fine sand, fine sand, loamy sand, or sand. It has distinct or prominent mottles. The 2Bkg horizon has hue of 5Y or 2.5Y, value of 5 to 7 (6 to 8 dry), and chroma of 1 to 3. The 2Cg horizon has hue of 2.5Y or 5Y, value of 5 or 6 (6 or 7 dry), and chroma of 1 to 3. It has distinct or prominent mottles. It is loam, clay loam, sandy loam, fine sandy loam, silty clay loam, or silt loam.

La Prairie Series

The La Prairie series consists of very deep, moderately well drained, moderately permeable soils on flood plains and terraces. These soils formed in alluvium. Slope is 0 to 1 percent.

Typical pedon of La Prairie loam, 2,080 feet north and 520 feet west of the southeast corner of sec. 15, T. 146 N., R. 64 W.

Ap—0 to 8 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine granular structure; slightly hard and friable; slightly sticky and slightly plastic; many very fine roots; slightly alkaline; abrupt smooth boundary.

A1—8 to 16 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; slightly hard and friable; slightly sticky and slightly plastic; common very fine roots; slightly alkaline; clear wavy boundary.

A2—16 to 24 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; weak coarse prismatic structure parting to weak coarse subangular blocky; slightly hard and friable; slightly sticky and slightly plastic; common very fine roots; slightly alkaline; clear smooth boundary.

Bw1—24 to 45 inches; very dark grayish brown (10YR

3/2) loam, dark grayish brown (10YR 4/2) dry; weak coarse prismatic structure parting to weak coarse subangular blocky; slightly hard and friable; slightly sticky and slightly plastic; few very fine roots; few fine irregularly shaped soft masses of lime; slightly alkaline; clear irregular boundary.

Bw2—45 to 50 inches; dark brown (10YR 4/3) loam, brown (10YR 5/3) dry; weak coarse subangular blocky structure; slightly hard and friable; slightly sticky and slightly plastic; common medium irregularly shaped soft masses of lime; strong effervescence; moderately alkaline; clear wavy boundary.

C—50 to 60 inches; light olive brown (2.5Y 5/4) loam, light yellowish brown (2.5Y 6/4) dry; massive; slightly hard and very friable; slightly sticky and nonplastic; slight effervescence; slightly alkaline.

The thickness of the mollic epipedon ranges from 16 to more than 40 inches. The depth to carbonates ranges from 0 to 40 inches.

Some pedons have an Ab horizon. The Bw horizon has hue of 10YR or 2.5Y, value of 2 to 4 (3 to 5 dry), and chroma of 1 to 3. The C horizon has hue of 10YR to 5Y, value of 3 to 5 (4 to 7 dry), and chroma of 1 to 4. In some pedons it has faint to distinct mottles. Some pedons have strata, which range from sand to clay, below a depth of 40 inches.

Lallie Series

The Lallie series consists of very deep, poorly drained, slowly permeable, calcareous soils on lake plains. These soils formed in glaciolacustrine deposits. Slope is 0 to 1 percent.

The Lallie soils in this county have slightly less clay in the profile than is definitive for the series. This difference, however, does not affect the use and management of the soils.

Typical pedon of Lallie loam, in an area of Lallie, saline-Minnewaukan complex; 1,500 feet north and 1,270 feet west of the southeast corner of sec. 9, T. 147 N., R. 62 W.

Az—0 to 5 inches; stratified, very dark gray (10YR 3/1) and black (10YR 2/1) loam, dark gray (10YR 4/1) and very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; hard and friable; slightly sticky and slightly plastic; many very fine roots; few snail shells; common fine flecks of salt; strong effervescence; slightly alkaline; abrupt smooth boundary.

C1—5 to 15 inches; stratified, dark grayish brown (2.5Y 4/2) and very dark gray (10YR 3/1) silty clay loam, light brownish gray (2.5Y 6/2) and gray (10YR 5/1) dry; common fine distinct dark yellowish brown (10YR 4/4) mottles; weak medium subangular blocky structure; hard and firm; sticky and plastic; common very fine roots; ½-inch-thick layer of black (10YR 2/1) silty clay loam at a depth of 6 inches; strong effervescence; slightly alkaline; abrupt irregular boundary.

C2—15 to 60 inches; light olive gray (5Y 6/2) silty clay loam, light gray (5Y 7/2) dry; common medium distinct light olive brown (2.5Y 5/4) mottles; massive; hard and firm; sticky and plastic; few very fine roots to a depth of 30 inches; strong effervescence; slightly alkaline.

The A horizon has hue of 10YR to 5Y, value of 2 to 4 (3 to 6 dry), and chroma of 1 or 2. Some pedons have an Ab horizon, which is as much as 8 inches thick. The C horizon has value of 3 to 6 (5 to 8 dry) and chroma of 2 or less. It is silt loam or silty clay loam.

Larson Series

The Larson series consists of very deep, somewhat poorly drained, slowly permeable, sodic soils on till plains. These soils formed in glacial till. Slope ranges from 0 to 2 percent.

Typical pedon of Larson loam, in an area of Larson-Cathay loams, 0 to 2 percent slopes; 1,825 feet west and 1,625 feet north of the southeast corner of sec. 33, T. 146 N., R. 67 W.

Ap—0 to 9 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; slightly hard and friable; slightly sticky and slightly plastic; few fine roots; about 5 percent gravel; neutral; abrupt smooth boundary.

E—9 to 11 inches; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; weak medium subangular blocky structure parting to weak thin platy; slightly hard and friable; slightly sticky and slightly plastic; few fine roots; about 5 percent gravel; neutral; clear smooth boundary.

Btn—11 to 23 inches; black (10YR 2/1) clay loam, dark gray (10YR 4/1) dry; strong medium columnar structure parting to moderate fine subangular blocky; very hard and very firm; very sticky and very plastic; few fine roots along vertical faces of peds; many distinct clay films on faces of peds; about 5 percent gravel; slightly alkaline; clear smooth boundary.

Bk—23 to 33 inches; olive brown (2.5Y 4/4) loam, light yellowish brown (2.5Y 6/4) dry; common fine faint dark grayish brown (10YR 4/2) mottles; massive; hard and friable; slightly sticky and slightly plastic; about 5 percent gravel; common fine irregularly

shaped soft masses of lime; strong effervescence; moderately alkaline; gradual smooth boundary.
C—33 to 60 inches; olive brown (2.5Y 4/4) clay loam, light yellowish brown (2.5Y 6/4) dry; few fine prominent dark red (2.5YR 3/6) and distinct gray (2.5Y 5/0) mottles; massive; very hard and firm; very sticky and very plastic; about 10 percent gravel; common fine irregularly shaped soft masses of lime; slight effervescence; moderately alkaline.

The A horizon has hue of 10YR or 2.5Y and value of 2 or 3 (3 to 5 dry). The E horizon has hue of 10YR or 2.5Y, value of 2 to 5 (5 to 7 dry), and chroma of 1 or 2. In some pedons tillage has mixed the A and E horizons. The Btn horizon has hue of 10YR to 5Y, value of 2 to 4 (4 to 6 dry), and chroma of 1 to 3. The Bk horizon has hue of 2.5Y or 5Y, value of 4 to 6 (5 to 7 dry), and chroma of 1 to 4. It is loam or clay loam. The C horizon has hue of 2.5Y or 5Y, value of 4 to 6 (5 to 7 dry), and chroma of 2 to 4. It dominantly is loam or clay loam. Some pedons have layers of coarser textured material below a depth of 40 inches.

Letcher Series

The Letcher series consists of very deep, somewhat poorly drained, sodic soils on outwash plains. These soils formed in glaciofluvial deposits. Permeability is slow in the upper part of the profile and moderately rapid in the lower part. Slope ranges from 0 to 3 percent.

Typical pedon of Letcher fine sandy loam, 0 to 3 percent slopes, 2,450 feet west and 375 feet north of the southeast corner of sec. 20, T. 145 N., R. 66 W.

Ap—0 to 9 inches; black (10YR 2/1) fine sandy loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; slightly hard and very friable; nonsticky and nonplastic; many very fine and common fine roots; neutral; abrupt smooth boundary.
E—9 to 15 inches; very dark brown (10YR 2/2) fine sandy loam, dark gray (10YR 4/1) dry; weak medium subangular blocky structure parting to weak medium platy; slightly hard and very friable; nonsticky and nonplastic; common very fine and few fine roots; slightly acid; abrupt smooth boundary.
Btn—15 to 22 inches; very dark grayish brown (10YR 3/2) fine sandy loam, grayish brown (10YR 5/2) dry; strong coarse columnar structure; very hard and firm; nonsticky and nonplastic; common very fine roots along faces of peds and few very fine roots in interiors of peds; common light brownish gray (10YR 6/2) dry sand coatings on top of columns; common thin faint very dark brown (10YR 2/2) clay films on faces of peds; moderately alkaline; clear wavy boundary.
Bk1—22 to 30 inches; dark grayish brown (2.5Y 4/2) fine sandy loam, grayish brown (2.5Y 5/2) dry; few fine prominent dark yellowish brown (10YR 4/4) mottles; weak medium subangular blocky structure; hard and friable; nonsticky and nonplastic; few very fine roots; common thin threads of lime; strong effervescence; moderately alkaline; gradual wavy boundary.
Bk2—30 to 36 inches; light olive brown (2.5Y 5/4) fine sandy loam, light gray (2.5Y 7/2) dry; few fine distinct dark grayish brown (2.5Y 4/2) and dark brown (10YR 4/3) mottles; weak medium subangular blocky structure; slightly hard and very friable; nonsticky and nonplastic; lime disseminated throughout; violent effervescence; moderately alkaline; gradual wavy boundary.
C—36 to 60 inches; light olive brown (2.5Y 5/4) loamy fine sand, light yellowish brown (2.5Y 6/4) dry; common fine distinct grayish brown (2.5Y 5/2) and light olive brown (2.5Y 5/6) mottles; massive; soft and very friable; nonsticky and nonplastic; slight effervescence; moderately alkaline.

The depth to carbonates ranges from 10 to 25 inches. The A horizon has value of 2 or 3 (3 to 5 dry). The E horizon has hue of 10YR or 2.5Y, value of 2 to 5 (4 to 7 dry), and chroma of 1 or 2. It is loamy fine sand, fine sandy loam, or sandy loam. In plowed areas some pedons do not have an E horizon. The Bt horizon has hue of 10YR or 2.5Y, value of 3 or 4 (4 or 5 dry), and chroma of 2 or 3. It is sandy loam, fine sandy loam, or loam. The C horizon has hue of 10YR to 5Y, value of 3 to 6 (5 to 7 dry), and chroma of 1 to 4. It is sandy loam, fine sandy loam, loam, or loamy fine sand.

Lohnes Series

The Lohnes series consists of very deep, well drained, rapidly permeable soils on outwash plains. These soils formed in glaciofluvial deposits. Slope ranges from 0 to 6 percent.

Typical pedon of Lohnes loamy coarse sand, 0 to 6 percent slopes, 850 feet west and 340 feet south of the northeast corner of sec. 1, T. 147 N., R. 64 W.

Ap—0 to 11 inches; black (10YR 2/1) loamy coarse sand, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; soft and very friable; nonsticky and nonplastic; few very fine roots; about 2 percent gravel; neutral; gradual smooth boundary.
AC—11 to 20 inches; very dark brown (10YR 2/2) loamy coarse sand, dark grayish brown (10YR 4/2)

dry; weak fine subangular blocky structure; soft and very friable; nonsticky and nonplastic; few very fine roots; discontinuous black (10YR 2/1) coatings on faces of peds; about 2 percent gravel; neutral; gradual smooth boundary.

C1—20 to 50 inches; dark yellowish brown (10YR 3/4) coarse sand, dark yellowish brown (10YR 4/4) dry; single grain; loose; nonsticky and nonplastic; about 7 percent gravel; slightly alkaline; gradual smooth boundary.

C2—50 to 60 inches; dark brown (10YR 4/3) coarse sand, brown (10YR 5/3) dry; many medium faint pale brown (10YR 6/3) mottles; single grain; loose; nonsticky and nonplastic; about 3 percent gravel; slight effervescence; slightly alkaline.

The thickness of the mollic epipedon ranges from 10 to 20 inches. The A horizon has value of 2 or 3 (3 or 4 dry). The C horizon has hue of 10YR or 2.5Y, value of 3 to 6 (4 to 7 dry), and chroma of 2 to 4. It is coarse sand or loamy coarse sand. In some pedons the C horizon is not mottled.

Maddock Series

The Maddock series consists of very deep, well drained soils on outwash plains, lake plains, moraines, and mantled till plains. These soils formed in glaciofluvial deposits. Permeability is rapid, or it is rapid in the upper part of the profile and moderately slow in the lower part. Slope ranges from 0 to 15 percent.

Typical pedon of Maddock loamy fine sand, 0 to 6 percent slopes, 2,410 feet west and 350 feet north of the southeast corner of sec. 5, T. 147 N., R. 63 W.

Ap—0 to 8 inches; black (10YR 2/1) loamy fine sand, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; soft and very friable; nonsticky and nonplastic; common very fine roots; neutral; abrupt smooth boundary.

A—8 to 12 inches; black (10YR 2/1) loamy fine sand, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; soft and very friable; nonsticky and nonplastic; few very fine roots; neutral; clear smooth boundary.

C1—12 to 37 inches; dark yellowish brown (10YR 4/4) fine sand, yellowish brown (10YR 5/4) dry; single grain; soft and very friable; nonsticky and nonplastic; few very fine roots; neutral; gradual smooth boundary.

C2—37 to 60 inches; light olive brown (2.5Y 5/4) fine sand, light yellowish brown (2.5Y 6/4) dry; single grain; soft and very friable; nonsticky and nonplastic; slightly alkaline.

The thickness of the mollic epipedon ranges from 10 to 16 inches. Some pedons have carbonates.

The A horizon has value of 2 or 3 (3 to 5 dry). It is loamy fine sand or sandy loam. Some pedons have an AC or Bw horizon, which is 2 to 10 inches thick. The C horizon has value of 3 to 6 (4 to 7 dry) and chroma of 2 to 4. It dominantly is sand, fine sand, or loamy fine sand. Some pedons are clay loam or loam below a depth of 40 inches.

Manfred Series

The Manfred series consists of very deep, poorly drained, slowly permeable, sodic, saline soils on till plains. These soils formed in alluvium and glacial till. Slope is 0 to 1 percent.

Typical pedon of Manfred loam, 2,025 feet south and 275 feet east of the northwest corner of sec. 27, T. 146 N., R. 67 W.

A—0 to 7 inches; black (N 2/0) loam, very dark gray (10YR 3/1) dry; weak fine granular structure; slightly hard and friable; slightly sticky and slightly plastic; many fine roots; about 5 percent gravel; neutral; clear smooth boundary.

Btng—7 to 13 inches; dark olive gray (5Y 3/2) clay loam, dark gray (5Y 4/1) dry; moderate fine subangular blocky structure; very hard and very firm; very sticky and very plastic; few fine roots; many distinct clay films on faces of peds; about 5 percent gravel; moderately alkaline; clear smooth boundary.

Byzg—13 to 22 inches; olive gray (5Y 5/2) loam, olive (5Y 5/3) dry; common fine prominent yellowish brown (10YR 5/8) mottles; weak fine prismatic structure parting to weak fine subangular blocky; hard and friable; sticky and plastic; few very fine roots; few faint clay films on faces of peds; about 5 percent gravel; few fine masses of salt; few fine nests of gypsum; moderately alkaline; clear smooth boundary.

Bkzg—22 to 33 inches; olive gray (5Y 5/2) loam, olive (5Y 5/3) dry; common medium prominent yellowish brown (10YR 5/8) mottles; weak fine prismatic structure; hard and friable; sticky and plastic; common distinct clay films on vertical faces of peds; about 5 percent gravel; common fine masses of salt; few medium irregularly shaped soft masses of lime; slight effervescence; moderately alkaline; abrupt smooth boundary.

Bkz—33 to 46 inches; light olive brown (2.5Y 5/4) silt loam, light yellowish brown (2.5Y 6/4) dry; common fine distinct gray (N 6/0) and olive yellow (2.5Y 6/8) mottles; massive; hard and friable; slightly sticky and slightly plastic; about 5 percent gravel; common

masses of salt; lime disseminated throughout; violent effervescence; moderately alkaline; clear smooth boundary.

C—46 to 60 inches; dark grayish brown (2.5Y 4/2) loam, grayish brown (2.5Y 5/2) dry; few fine distinct olive yellow (2.5Y 6/8) mottles; massive; hard and friable; sticky and plastic; about 5 percent gravel; slight effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 7 to 15 inches. The A horizon has hue of 5Y to 10YR, or it is neutral in hue. It has value of 2 or 3 (3 or 4 dry) and chroma of 0 or 1. The B horizon has value of 2 to 6 (3 to 7 dry) and chroma of 1 to 4. The C horizon has hue of 2.5Y or 5Y, value of 4 or 5 (5 or 6 dry), and chroma of 1 to 3. It is loam or clay loam.

Minnewaukan Series

The Minnewaukan series consists of very deep, poorly drained, rapidly permeable soils on lake plains. These soils formed in glaciolacustrine deposits. Slope is 0 to 1 percent.

Typical pedon of Minnewaukan loamy fine sand, 1,300 feet north and 1,800 feet east of the southwest corner of sec. 18, T. 147 N., R. 64 W.

A—0 to 1 inch; black (10YR 2/1) loamy fine sand, very dark grayish brown (10YR 3/2) dry; weak very fine granular structure; soft and very friable; nonsticky and nonplastic; many very fine roots; slight effervescence; slightly alkaline; abrupt smooth boundary.

AC—1 to 9 inches; dark gray (5Y 4/1) fine sand, gray (5Y 5/1) dry; common fine prominent dark yellowish brown (10YR 4/6) mottles; single grain; loose; nonsticky and nonplastic; common very fine roots; slight effervescence; slightly alkaline; clear wavy boundary.

Cg1—9 to 23 inches; gray (5Y 5/1) fine sand, light gray (5Y 6/1) dry; few fine prominent yellowish brown (10YR 5/6) mottles; single grain; loose; nonsticky and nonplastic; few very fine roots; slight effervescence; slightly alkaline; clear smooth boundary.

Cg2—23 to 28 inches; olive gray (5Y 4/2) loamy fine sand, olive gray (5Y 5/2) dry; few medium prominent dark yellowish brown (10YR 4/6) mottles; single grain; loose; nonsticky and nonplastic; few very fine roots; strong effervescence; moderately alkaline; clear smooth boundary.

Cg3—28 to 40 inches; gray (5Y 5/1) fine sand, gray (5Y 6/1) dry; single grain; loose; nonsticky and nonplastic; strong effervescence; moderately alkaline; clear smooth boundary.

Cg4—40 to 43 inches; gray (5Y 5/1) fine sandy loam, light gray (5Y 6/1) dry; common medium distinct olive (5Y 5/3) mottles; massive; slightly hard and friable; nonsticky and nonplastic; strong effervescence; moderately alkaline; clear smooth boundary.

Cg5—43 to 60 inches; dark gray (5Y 4/1) fine sand, gray (5Y 5/1) dry; common fine prominent dark yellowish brown (10YR 4/6) mottles; single grain; loose; nonsticky and nonplastic; strong effervescence; moderately alkaline.

The A and AC horizons have hue of 10YR to 5Y, value of 3 to 6 dry, and chroma of 1 or 2. The C horizon has hue of 10YR to 5Y, value of 3 to 5 (4 to 7 dry), and chroma of 1 to 3. Some pedons have layers of loam, silt loam, or clay loam below a depth of 40 inches. Some pedons have thin horizons that have 1 to 20 percent gravel.

Miranda Series

The Miranda series consists of very deep, somewhat poorly drained, very slowly permeable, sodic, saline soils on till plains. These soils formed in glacial till. Slope ranges from 0 to 2 percent.

Typical pedon of Miranda loam, in an area of Miranda-Larson loams, 0 to 2 percent slopes; 2,400 feet south and 210 feet east of the northwest corner of sec. 22, T. 145 N., R. 66 W.

A—0 to 2 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; moderate fine granular structure; slightly hard and friable; slightly sticky and slightly plastic; many very fine roots; neutral; abrupt smooth boundary.

E—2 to 4 inches; very dark gray (10YR 3/1) silt loam, dark gray (10YR 4/1) dry; weak thin platy structure; slightly hard and friable; slightly sticky and slightly plastic; many very fine roots; slightly acid; abrupt wavy boundary.

Btn—4 to 10 inches; very dark brown (10YR 2/2) clay loam, very dark grayish brown (10YR 3/2) dry; strong coarse columnar structure parting to strong angular blocky; very hard and firm; sticky and plastic; common very fine roots along faces of peds; continuous moderately thick clay films on faces of peds; moderately alkaline; clear wavy boundary.

Btnz—10 to 15 inches; very dark grayish brown (2.5Y 3/2) clay loam, dark grayish brown (2.5Y 4/2) dry; strong fine angular blocky structure; very hard and firm; sticky and plastic; few very fine roots along faces of peds; continuous moderately thick clay films on faces of peds; few fine threads of salts; moderately alkaline; clear wavy boundary.

Bkz1—15 to 25 inches; dark grayish brown (2.5Y 4/2) clay loam, light brownish gray (2.5Y 6/2) dry; few fine prominent yellowish brown (10YR 5/6) mottles; moderate fine angular blocky structure; hard and firm; sticky and plastic; few very fine roots along faces of peds; common fine threads of salts; many medium irregularly shaped soft masses of lime; strong effervescence; moderately alkaline; clear wavy boundary.

Bkz2—25 to 32 inches; dark grayish brown (2.5Y 4/2) clay loam, pale yellow (2.5Y 7/4) dry; few fine prominent yellowish brown (10YR 5/6) mottles; massive; hard and firm; sticky and plastic; few fine threads of salts; many large irregularly shaped soft masses of lime; strong effervescence; moderately alkaline; clear wavy boundary.

C—32 to 60 inches; olive brown (2.5Y 4/4) clay loam, light yellowish brown (2.5Y 6/4) dry; common medium prominent yellowish brown (10YR 5/6) mottles; massive; hard and firm; sticky and plastic; lime disseminated throughout; strong effervescence; moderately alkaline.

The depth to carbonates ranges from 5 to 25 inches. The combined thickness of the A and E horizons is less than 6 inches.

The E horizon has hue of 10YR or 2.5Y, value of 3 or 4 (4 to 7 dry), and chroma of 1 or 2. The Btn horizon has value of 2 to 4 (3 to 6 dry) and chroma of 1 to 4. The Bk and C horizons are loam or clay loam. The Bk horizon has hue of 10YR to 5Y, value of 3 to 6 (4 to 7 dry), and chroma of 2 to 4. The C horizon has hue of 10YR to 5Y, value of 3 to 7 (4 to 8 dry), and chroma of 1 to 4.

Parnell Series

The Parnell series consists of very deep, very poorly drained, slowly permeable soils on till plains. These soils formed in alluvium. Slope is 0 to 1 percent.

Typical pedon of Parnell silty clay loam, 1,600 feet west and 1,575 feet south of the northeast corner of sec. 27, T. 146 N., R. 67 W.

A1—0 to 4 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; weak fine granular structure; slightly hard and friable; slightly sticky and slightly plastic; many fine roots; neutral; clear smooth boundary.

A2—4 to 9 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; slightly hard and friable; slightly sticky and slightly plastic; few fine roots; neutral; clear smooth boundary.

Btg1—9 to 30 inches; dark olive gray (5Y 3/2) clay loam, dark gray (5Y 4/1) dry; weak fine prismatic structure parting to moderate fine subangular blocky; very hard and very firm; very sticky and very plastic; few fine roots; discontinuous black (5Y 2.5/1) coatings on faces of peds; many distinct clay films on faces of peds; neutral; diffuse smooth boundary.

Btg2—30 to 44 inches; olive gray (5Y 4/2) clay loam, olive gray (5Y 5/2) dry; few fine prominent yellowish brown (10YR 5/6) mottles; weak fine prismatic structure parting to moderate fine subangular blocky; very hard and firm; very sticky and very plastic; few very fine roots; discontinuous dark gray (5Y 4/1) coatings on faces of peds; many distinct clay films on faces of peds; slightly alkaline; gradual smooth boundary.

Cg—44 to 60 inches; olive gray (5Y 5/2) clay loam, light olive gray (5Y 6/2) dry; many fine prominent strong brown (7.5YR 5/6) mottles; massive; very hard and firm; sticky and plastic; slightly alkaline.

The thickness of the mollic epipedon ranges from 24 to 50 inches. The depth to lime ranges from 35 to more than 60 inches.

Some pedons have an O horizon, which is as much as 4 inches thick. The A horizon has hue of 10YR to 5Y, or it is neutral in hue. It has faint mottles in some pedons. Some pedons have an E horizon, which is 1 to 4 inches thick. The Btg horizon has hue of 2.5Y or 5Y, value of 2 to 4 (3 to 5 dry), and chroma of 1 or 2. It is clay loam, silty clay loam, silty clay, or clay. The Cg horizon has hue of 2.5Y or 5Y, value of 4 or 5 (5 or 6 dry), and chroma of 1 or 2. It is clay loam, loam, or silty clay loam. Mottles are distinct or prominent.

Sioux Series

The Sioux series consists of very deep, excessively drained soils on outwash plains and terraces. These soils formed in glaciofluvial deposits. Permeability is moderately rapid in the upper part of the profile and very rapid in the lower part. Slope ranges from 1 to 9 percent.

Typical pedon of Sioux loam, in an area of Sioux-Arvilla complex, 1 to 9 percent slopes; 1,500 feet east and 420 feet north of the southwest corner of sec. 18, T. 146 N., R. 64 W.

A—0 to 7 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; moderate fine granular structure; soft and very friable; slightly sticky and nonplastic; many very fine and common fine roots; about 5 percent gravel; slightly alkaline; abrupt wavy boundary.

AC—7 to 13 inches; dark brown (10YR 3/3) gravelly

loamy sand, brown (10YR 4/3) dry; single grain; loose; nonsticky and nonplastic; common very fine roots; about 20 percent gravel; slight effervescence; moderately alkaline; gradual wavy boundary.

C—13 to 60 inches; dark yellowish brown (10YR 4/4) very gravelly sand, yellowish brown (10YR 5/4) dry; single grain; loose; nonsticky and nonplastic; few very fine roots in the upper part; about 40 percent gravel; slight effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 7 to 14 inches. The depth to sand and gravel ranges from 6 to 14 inches.

The A horizon has value of 2 or 3 (3 to 5 dry). The AC horizon has value of 3 or 4 (4 to 6 dry) and chroma of 2 or 3. The C horizon has hue of 10YR or 2.5Y, value of 4 to 6 (5 to 7 dry), and chroma of 2 to 4. It is gravelly sand, gravelly loamy sand, very gravelly sand, extremely gravelly sand, very gravelly coarse sand, or extremely gravelly coarse sand.

Southam Series

The Southam series consists of very deep, very poorly drained, slowly permeable, calcareous soils on till plains and lake plains. These soils formed in alluvium. Slope is 0 to 1 percent.

Typical pedon of Southam silt loam, 1,000 feet south and 80 feet west of the northeast corner of sec. 36, T. 147 N., R. 65 W.

Ag1—0 to 10 inches; black (5Y 2/2) silt loam, dark olive gray (5Y 3/2) dry; few fine prominent dark yellowish brown (10YR 3/4) mottles; weak fine subangular blocky structure; slightly hard and friable; slightly sticky and slightly plastic; common very fine roots; few fine snail shells; slight effervescence; moderately alkaline; abrupt smooth boundary.

Ag2—10 to 17 inches; black (N 2/0) silty clay loam, very dark gray (N 3/0) dry; weak fine subangular blocky structure; slightly hard and friable; slightly sticky and slightly plastic; few very fine roots; few fine snail shells; slight effervescence; moderately alkaline; gradual smooth boundary.

Ag3—17 to 32 inches; black (N 2/0) silty clay loam, very dark gray (N 3/0) dry; weak fine subangular blocky structure; hard and firm; sticky and plastic; few very fine roots; few fine snail shells; slight effervescence; moderately alkaline; gradual smooth boundary.

Cg—32 to 60 inches; black (5Y 2/1) silty clay, very dark gray (5Y 3/1) dry; massive; very hard and very firm; very sticky and very plastic; few fine snail shells; slight effervescence; moderately alkaline.

Some pedons have an O horizon, which is 1 to 4 inches thick. The A horizon has hue of 10YR to 5Y, or it is neutral in hue. It has value of 2 or 3 (3 or 4 dry). The C horizon has hue of 2.5Y or 5Y, or it is neutral in hue. It has value of 2 to 6 (3 to 8 dry) and chroma of 2 or less.

Spottswood Series

The Spottswood series consists of very deep, moderately well drained soils on terraces and outwash plains. These soils formed in glaciofluvial deposits. Permeability is moderate in the upper part of the profile and rapid in the lower part. Slope ranges from 0 to 3 percent.

Typical pedon of Spottswood loam, 0 to 3 percent slopes, 2,380 feet north and 2,000 feet west of the southeast corner of sec. 12, T. 146 N., R. 64 W.

Ap—0 to 8 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; slightly hard and friable; slightly sticky and slightly plastic; common very fine roots; about 2 percent gravel; neutral; abrupt smooth boundary.

Bw1—8 to 20 inches; very dark brown (10YR 2/2) loam, very dark grayish brown (10YR 3/2) dry; weak medium prismatic structure parting to moderate medium subangular blocky; slightly hard and friable; slightly sticky and slightly plastic; common very fine roots; about 3 percent gravel; neutral; clear smooth boundary.

Bw2—20 to 25 inches; dark grayish brown (2.5Y 4/2) loam, grayish brown (10YR 5/2) dry; weak medium prismatic structure; slightly hard and friable; slightly sticky and slightly plastic; few very fine roots; crusts of lime on underside of pebbles; about 10 percent gravel; slight effervescence; slightly alkaline; clear wavy boundary.

2C1—25 to 30 inches; light olive brown (2.5Y 5/4) gravelly sand, light yellowish brown (2.5Y 6/4) dry; single grain; loose; nonsticky and nonplastic; crusts of lime on underside of pebbles; about 20 percent gravel; slight effervescence; slightly alkaline; clear wavy boundary.

2C2—30 to 40 inches; light olive brown (2.5Y 5/4) fine sand, pale yellow (2.5Y 7/4) dry; many medium prominent dark yellowish brown (10YR 4/6) mottles; single grain; loose; nonsticky and nonplastic; about 2 percent gravel; slight effervescence; slightly alkaline; clear wavy boundary.

2C3—40 to 60 inches; grayish brown (2.5Y 5/2) fine sand, light gray (2.5Y 7/2) dry; few medium distinct light olive brown (2.5Y 5/4) mottles; single grain; loose; nonsticky and nonplastic; slight effervescence; slightly alkaline.

The thickness of the mollic epipedon ranges from 16 to 30 inches. The depth to sand and gravel ranges from 20 to 40 inches.

The A horizon has value of 2 or 3 (3 or 4 dry). The Bw horizon has value of 2 to 4 (3 to 5 dry) and chroma of 1 or 2. Some pedons have a Bk horizon. The 2C horizon has hue of 10YR or 2.5Y, value of 4 to 6 (5 to 7 dry), and chroma of 2 to 4. It has as much as 50 percent gravel.

Svea Series

The Svea series consists of very deep, well drained and moderately well drained, moderately slowly permeable soils on till plains and moraines. These soils formed in glacial till. Slope ranges from 0 to 15 percent.

Typical pedon of Svea loam, in an area of Svea-Barnes loams, 0 to 3 percent slopes; 1,000 feet west and 200 feet south of the northeast corner of sec. 30, T. 147 N., R. 62 W.

Ap—0 to 8 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine granular structure; slightly hard and friable; slightly sticky and slightly plastic; few fine roots; slightly alkaline; abrupt smooth boundary.

A—8 to 20 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak medium prismatic structure parting to weak fine subangular blocky; hard and friable; sticky and plastic; few very fine roots; about 1 percent gravel; slightly alkaline; clear smooth boundary.

Bw—20 to 25 inches; very dark grayish brown (2.5Y 3/2) loam, grayish brown (2.5Y 5/2) dry; weak medium prismatic structure parting to weak fine subangular blocky; hard and friable; slightly sticky and slightly plastic; few very fine roots; about 1 percent gravel; slightly alkaline; clear smooth boundary.

Bk—25 to 32 inches; light yellowish brown (2.5Y 6/4) loam, light gray (2.5Y 7/2) dry; weak fine prismatic structure parting to weak fine subangular blocky; hard and friable; slightly sticky and slightly plastic; few very fine roots; about 1 percent gravel; common fine irregularly shaped soft masses of lime; violent effervescence; moderately alkaline; clear smooth boundary.

C—32 to 60 inches; olive brown (2.5Y 4/4) loam, light yellowish brown (2.5Y 6/4) dry; few fine distinct grayish brown (2.5Y 5/2) mottles; massive; hard and friable; slightly sticky and slightly plastic; few very fine roots; about 2 percent gravel; strong effervescence; slightly alkaline.

The thickness of the mollic epipedon ranges from 16 to 30 inches. The A horizon has value of 2 or 3 (3 or 4 dry). The Bw horizon has hue of 10YR or 2.5Y, value of 2 to 4 (3 to 5 dry), and chroma of 2 to 4. The Bk horizon has hue of 10YR or 2.5Y, value of 4 to 6 (6 to 8 dry), and chroma of 2 to 4. The C horizon has value of 4 or 5 (5 or 6 dry) and chroma of 2 to 4. The B and C horizons are loam or clay loam.

Swenoda Series

The Swenoda series consists of very deep, moderately well drained soils on mantled lake plains, till plains, and moraines. These soils formed in eolian material, glaciolacustrine deposits, and glacial till. Permeability is moderately rapid in the upper part of the profile and moderately slow in the lower part. Slope ranges from 0 to 9 percent.

Typical pedon of Swenoda fine sandy loam, 0 to 6 percent slopes, 180 feet west and 135 feet north of the southeast corner of sec. 12, T. 146 N., R. 62 W.

Ap—0 to 11 inches; black (10YR 2/1) fine sandy loam, dark gray (10YR 4/1) dry; weak medium subangular blocky structure; soft and very friable; nonsticky and nonplastic; common very fine roots; neutral; abrupt smooth boundary.

Bw—11 to 22 inches; very dark grayish brown (10YR 3/2) fine sandy loam, dark grayish brown (10YR 4/2) dry; weak medium subangular blocky structure; soft and very friable; nonsticky and nonplastic; few very fine roots; neutral; abrupt wavy boundary.

Bk—22 to 32 inches; grayish brown (10YR 5/2) fine sandy loam, light gray (2.5Y 7/2) dry; weak coarse subangular blocky structure; slightly hard and friable; slightly sticky and slightly plastic; few very fine roots; lime disseminated throughout; violent effervescence; moderately alkaline; abrupt irregular boundary.

C1—32 to 37 inches; light olive brown (2.5Y 5/4) loamy fine sand, pale yellow (2.5Y 7/4) dry; few fine distinct yellowish brown (10YR 5/6) mottles; massive; soft and very friable; nonsticky and nonplastic; slight effervescence; slightly alkaline; abrupt irregular boundary.

2C2—37 to 60 inches; light olive brown (2.5Y 5/4) silty clay loam, pale yellow (2.5Y 7/4) dry; many medium prominent gray (10YR 5/1) mottles; massive; slightly hard and firm; sticky and plastic; slight effervescence; moderately alkaline.

The depth to carbonates and to silty and loamy sediments ranges from 20 to 40 inches. A thin stone line marks the boundary between the C1 and 2C2 horizons in some pedons.

The A horizon has value of 2 or 3 (3 or 4 dry). The

Bw horizon has hue of 10YR or 2.5Y, value of 2 to 4 (3 to 6 dry), and chroma of 1 to 4. The Bk horizon has value of 4 to 6 (6 to 8 dry) and chroma of 2 to 4. It is sandy loam or fine sandy loam. The C and 2C horizons have hue of 10YR or 2.5Y, value of 4 to 6 (6 to 8 dry), and chroma of 2 to 6. The 2C horizon is silt loam, silty clay loam, loam, or clay loam. Some pedons do not have Bk and C horizons but have a 2Bk horizon.

Tonka Series

The Tonka series consists of very deep, poorly drained, slowly permeable soils on till plains. These soils formed in alluvium and glacial till. Slope is 0 to 1 percent.

Typical pedon of Tonka silt loam, 2,500 feet north and 1,200 feet west of the southeast corner of sec. 29, T. 145 N., R. 62 W.

Ap—0 to 9 inches; black (10YR 2/1) silt loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; hard and firm; slightly sticky and slightly plastic; common fine roots; neutral; clear smooth boundary.

E—9 to 15 inches; dark gray (10YR 4/1) silt loam, gray (10YR 6/1) dry; few medium distinct brown (10YR 4/3) mottles; moderate thin platy structure; slightly hard and friable; slightly sticky and slightly plastic; common very fine roots; slightly acid; clear wavy boundary.

Bt—15 to 24 inches; very dark grayish brown (2.5Y 3/2) silty clay, grayish brown (2.5Y 5/2) dry; strong fine angular blocky structure; hard and firm; very sticky and very plastic; few very fine roots; many faint clay films on faces of peds; slightly acid; clear smooth boundary.

Btg—24 to 29 inches; olive gray (5Y 4/2) clay, light olive gray (5Y 6/2) dry; few fine prominent yellowish brown (10YR 5/6) mottles; weak fine subangular blocky structure; hard and firm; very sticky and very plastic; few very fine roots; about 2 percent gravel; few faint clay films on faces of peds; slightly acid; clear smooth boundary.

Bk—29 to 50 inches; light brownish gray (2.5Y 6/2) loam, white (2.5Y 8/2) dry; few fine prominent yellowish brown (10YR 5/6) mottles; weak very fine subangular blocky structure; slightly hard and friable; sticky and plastic; few very fine roots; about 2 percent gravel; lime disseminated throughout; violent effervescence; moderately alkaline; gradual wavy boundary.

C—50 to 60 inches; olive brown (2.5Y 4/4) loam, light yellowish brown (2.5Y 6/4) dry; many medium distinct grayish brown (2.5Y 5/2) mottles; massive; hard and firm; sticky and plastic; about 2 percent gravel; slight effervescence; slightly alkaline.

The depth to lime ranges from 20 to more than 60 inches. The E horizon has hue of 10YR or 2.5Y, value of 3 to 5 (5 to 7 dry), and chroma of 1 or 2. It is silt loam or loam. The Btg horizon has hue of 10YR to 5Y, value of 2 to 4 (4 to 6 dry), and chroma of 1 or 2. It is silty clay, clay, clay loam, or silty clay loam. Some pedons do not have a Bk horizon. The C horizon has hue of 2.5Y or 5Y, value of 4 or 5 (5 or 6 dry), and chroma of 1 to 4.

Towner Series

The Towner series consists of very deep, moderately well drained soils on mantled till plains and moraines. These soils formed in glaciofluvial deposits and glacial till. Permeability is rapid in the upper part of the profile and moderately slow in the lower part. Slope ranges from 0 to 9 percent.

Typical pedon of Towner sandy loam, in an area of Towner-Barnes sandy loams, 0 to 3 percent slopes; 1,650 feet west and 1,500 feet north of the southeast corner of sec. 24, T. 147 N., R. 63 W.

Ap—0 to 8 inches; black (10YR 2/1) sandy loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; slightly hard and friable; slightly sticky and slightly plastic; common very fine roots; neutral; abrupt smooth boundary.

A—8 to 14 inches; black (10YR 2/1) sandy loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; slightly hard and very friable; slightly sticky and slightly plastic; few very fine roots; neutral; gradual smooth boundary.

Bw1—14 to 25 inches; very dark grayish brown (10YR 3/2) loamy sand, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; soft and very friable; nonsticky and nonplastic; few very fine roots; slightly alkaline; gradual smooth boundary.

Bw2—25 to 34 inches; dark brown (10YR 4/3) loamy sand, brown (10YR 5/3) dry; weak fine subangular blocky structure; soft and very friable; nonsticky and nonplastic; slightly alkaline; gradual smooth boundary.

2C—34 to 60 inches; olive (5Y 4/3) loam, pale olive (5Y 6/3) dry; massive; hard and friable; sticky and plastic; about 2 percent gravel; few fine irregularly shaped soft masses of lime; strong effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 16 to 34 inches. Some pedons have a 2Bk horizon. Depth

to the 2C or 2Bk horizon ranges from 20 to 40 inches.

The A horizon has value of 2 or 3 (3 or 4 dry). It is sandy loam or loamy fine sand. The Bw horizon has hue of 10YR or 2.5Y, value of 3 to 5 (4 to 6 dry), and chroma of 2 to 4. It is loamy fine sand, fine sand, or loamy sand. The 2C horizon has hue of 2.5Y or 5Y, value of 4 to 6 (6 to 8 dry), and chroma of 2 to 4. It is loam, silt loam, or clay loam.

Ulen Series

The Ulen series consists of very deep, somewhat poorly drained, rapidly permeable, highly calcareous soils on outwash plains and lake plains. These soils formed in glaciolacustrine and glaciofluvial deposits. Slope ranges from 0 to 2 percent.

Typical pedon of Ulen fine sandy loam, in an area of Ulen-Hecla fine sandy loams, 0 to 2 percent slopes; 2,600 feet north and 600 feet west of the southeast corner of sec. 36, T. 147 N., R. 62 W.

A—0 to 9 inches; black (10YR 2/1) fine sandy loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; slightly hard and very friable; nonsticky and nonplastic; common very fine and few fine roots; slight effervescence; moderately alkaline; clear smooth boundary.

Ak—9 to 13 inches; very dark grayish brown (10YR 3/2) loamy fine sand, dark grayish brown (10YR 4/2) dry; weak medium subangular blocky structure; soft and very friable; nonsticky and nonplastic; common very fine and few fine roots; lime disseminated throughout; strong effervescence; moderately alkaline; clear wavy boundary.

Bk1—13 to 20 inches; dark grayish brown (10YR 4/2) loamy fine sand, grayish brown (10YR 5/2) dry; few fine distinct dark yellowish brown (10YR 4/4) mottles; weak medium subangular blocky structure; soft and very friable; nonsticky and nonplastic; few very fine and fine roots; lime disseminated throughout; strong effervescence; moderately alkaline; gradual wavy boundary.

Bk2—20 to 42 inches; grayish brown (10YR 5/2) loamy fine sand, light brownish gray (2.5Y 6/2) dry; weak medium subangular blocky structure; soft and very friable; nonsticky and nonplastic; few very fine and fine roots; lime disseminated throughout; strong effervescence; moderately alkaline; gradual wavy boundary.

C—42 to 60 inches; light olive brown (2.5Y 5/4) fine sand, light yellowish brown (2.5Y 6/4) dry; few medium distinct dark yellowish brown (10YR 4/4) mottles; single grain; loose; nonsticky and nonplastic; slight effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 10 to 20 inches. The A horizon has value of 3 to 5 dry. The Bk horizon has value of 5 to 7 dry and chroma of 2 or 3. It dominantly is loamy sand, loamy fine sand, or fine sand. It is sandy loam or fine sandy loam in the upper part of some pedons. The C horizon has hue of 10YR to 5Y, value of 4 to 6 (5 to 7 dry), and chroma of 2 to 6. It is fine sand, loamy fine sand, sand, or coarse sand.

Vallers Series

The Vallers series consists of very deep, poorly drained, moderately slowly permeable, highly calcareous, saline soils on till plains. These soils formed in glacial till. Slope is 0 to 1 percent.

Typical pedon of Vallers loam, in an area of Vallers and Hamerly loams, saline; 1,050 feet north and 690 feet east of the southwest corner of sec. 29, T. 147 N., R. 62 W.

A—0 to 12 inches; black (N 2/0) loam, very dark gray (N 3/0) dry; weak medium prismatic structure parting to weak fine subangular blocky; hard and friable; sticky and plastic; common very fine roots; few fine threads of gypsum; slight effervescence; slightly alkaline; clear smooth boundary.

Bkg—12 to 24 inches; light olive gray (5Y 6/2) loam, light gray (5Y 7/2) dry; few fine prominent yellowish brown (10YR 5/6) mottles; weak medium prismatic structure parting to weak fine subangular blocky; hard and friable; sticky and plastic; few very fine roots; about 1 percent gravel; common medium irregularly shaped soft masses of lime; violent effervescence; slightly alkaline; gradual smooth boundary.

Cg—24 to 60 inches; olive gray (5Y 5/2) loam, light gray (5Y 7/2) dry; common fine prominent dark yellowish brown (10YR 4/6) mottles; massive; hard and friable; sticky and plastic; few very fine roots in the upper part; about 3 percent gravel; few fine irregularly shaped soft masses of lime; slight effervescence; slightly alkaline.

The thickness of the mollic epipedon ranges from 7 to 20 inches. The A horizon has hue of 10YR to 5Y, or it is neutral in hue. It has value of 2 or 3 (3 or 4 dry) and chroma of 0 or 1. The Bkg and Cg horizons are loam or clay loam. The Bkg horizon has hue of 10YR to 5Y, value of 3 to 6 (4 to 8 dry), and chroma of 1 or 2. The Cg horizon has hue of 2.5Y or 5Y, value of 4 to 7 (5 to 8 dry), and chroma of 1 to 3. In some pedons the Bkg and Cg horizons have nests of gypsum crystals.

Wyard Series

The Wyard series consists of very deep, somewhat poorly drained, moderately permeable soils on till plains. These soils formed in glacial till. Slope is 0 to 1 percent.

Typical pedon of Wyard loam, in an area of Fram-Wyard loams, 0 to 3 percent slopes; 1,650 feet north and 900 feet east of the southwest corner of sec. 3, T. 147 N., R. 67 W.

Ap—0 to 8 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; slightly hard and friable; slightly sticky and slightly plastic; common fine and many very fine roots; neutral; abrupt smooth boundary.

Bw1—8 to 17 inches; very dark brown (10YR 2/2) loam, dark grayish brown (10YR 4/2) dry; common fine prominent dark brown (7.5YR 3/4) mottles: weak coarse prismatic structure parting to weak thin platy; slightly hard and friable; slightly sticky and slightly plastic; few fine and common very fine roots; neutral; clear smooth boundary.

Bw2—17 to 24 inches; dark grayish brown (2.5Y 4/2) loam, grayish brown (2.5Y 5/2) dry; weak coarse prismatic structure parting to weak thin platy; slightly hard and friable; slightly sticky and slightly plastic; few very fine roots; about 1 percent gravel; neutral; clear wavy boundary.

Bk—24 to 30 inches; grayish brown (2.5Y 5/2) loam, light gray (2.5Y 7/2) dry; weak coarse prismatic structure; slightly hard and friable; slightly sticky and slightly plastic; few very fine roots; lime disseminated throughout; violent effervescence; slightly alkaline; clear wavy boundary.

C—30 to 60 inches; olive brown (2.5Y 4/4) loam, light yellowish brown (2.5Y 6/4) dry; common fine prominent strong brown (7.5YR 5/6) and few fine prominent gray (10YR 5/1) mottles; massive; slightly hard and friable; slightly sticky and slightly plastic; slight effervescence; slightly alkaline.

The thickness of the mollic epipedon ranges from 16 to 24 inches. The A horizon has value of 2 or 3 (3 to 5 dry). The Bw horizon has value of 2 to 4 (4 to 6 dry) and chroma of 1 to 4. The Bk horizon has hue of 2.5Y or 5Y, value of 4 to 6 (5 to 7 dry), and chroma of 2 to 4. It is loam or clay loam. The C horizon has hue of 2.5Y or 5Y, value of 4 to 6 (5 to 8 dry), and chroma of 2 to 4. It is loam, clay loam, or sandy loam.

Wyndmere Series

The Wyndmere series consists of very deep, somewhat poorly drained, highly calcareous soils on outwash plains and lake plains. These soils formed in glaciofluvial and glaciolacustrine deposits. Permeability is moderately rapid in the upper part of the profile and moderately slow in the lower part. Slope ranges from 0 to 3 percent.

Typical pedon of Wyndmere fine sandy loam, in an area of Wyndmere-Arveson complex, loamy substratum, 0 to 3 percent slopes; 250 feet north and 210 feet east of the southwest corner of sec. 13, T. 146 N., R. 62 W.

Ap—0 to 7 inches; black (10YR 2/1) fine sandy loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; slightly hard and friable; slightly sticky and nonplastic; few very fine roots; strong effervescence; slightly alkaline; abrupt smooth boundary.

A—7 to 11 inches; very dark brown (10YR 2/2) fine sandy loam, dark gray (10YR 4/1) dry; weak medium subangular blocky structure; slightly hard and friable; slightly sticky and nonplastic; few very fine roots; strong effervescence; slightly alkaline; clear wavy boundary.

Bk1—11 to 15 inches; very dark grayish brown (2.5Y 3/2) fine sandy loam, gray (10YR 5/1) dry; weak medium subangular blocky structure; slightly hard and friable; slightly sticky and nonplastic; many medium irregularly shaped soft masses of lime; violent effervescence; moderately alkaline; clear wavy boundary.

Bk2—15 to 23 inches; dark grayish brown (2.5Y 4/2) fine sandy loam, gray (10YR 6/1) dry; weak medium subangular blocky structure; slightly hard and friable; slightly sticky and nonplastic; few very fine roots; few fine irregularly shaped soft masses of lime; violent effervescence; moderately alkaline; gradual wavy boundary.

Bk3—23 to 29 inches; light brownish gray (2.5Y 6.2) fine sandy loam, white (2.5Y 8/2) dry; weak medium subangular blocky structure; slightly hard and friable; slightly sticky and nonplastic; few very fine roots; few fine irregularly shaped soft masses of lime; violent effervescence; moderately alkaline; clear wavy boundary.

C1—29 to 50 inches; light olive brown (2.5Y 5/4) loamy fine sand, light yellowish brown (2.5Y 6/4) dry; few fine prominent yellowish brown (10YR 5/6) mottles; single grain; loose; nonsticky and nonplastic; strong effervescence; moderately alkaline; gradual wavy boundary.

C2—50 to 55 inches; light olive brown (2.5Y 5/4) fine sand, light yellowish brown (2.5Y 6/4) dry; many medium prominent gray (N 6/0) and common medium prominent yellowish brown (10YR 5/8) mottles; single grain; loose; nonsticky and

nonplastic; slight effervescence; slightly alkaline; abrupt wavy boundary.

2C3—55 to 60 inches; light olive brown (2.5Y 5/4) clay loam, pale yellow (2.5Y 7/4) dry; many medium prominent gray (N 6/0) mottles; massive; hard and firm; sticky and plastic; few large nests of gypsum; slight effervescence; slightly alkaline.

The thickness of the mollic epipedon ranges from 7 to 16 inches. The A horizon has value of 2 or 3 (3 to 5 dry). The Bk horizon has value of 4 to 8 dry. It is fine sandy loam or sandy loam. The C horizon has value of 4 to 7 (5 to 8 dry) and chroma of 2 to 4. The C and 2C horizons range from clay loam to sand below a depth of 40 inches.

Formation of the Soils

Soil forms through the physical and chemical weathering of deposited or accumulated geologic material. Soil characteristics are determined by the physical and mineralogical composition of the parent material; the climate under which the soil formed and has existed since formation; the plant and animal life on and in the soil; the relief, or lay of the land; and the length of time that the processes of soil formation have acted on the soil material.

Climate and plant and animal life, mainly plants, are active factors of soil formation. They act on the parent material that has accumulated through the weathering of rocks and slowly change it into a natural body that has genetically related horizons. The effects of climate and plant and animal life are conditioned by relief. The parent material affects the kind of soil profile that forms and, in extreme cases, determines it almost entirely. Finally, time is needed for changing the parent material into a soil. Some time is always required for the differentiation of soil horizons. Usually, a long time is required for the development of distinct horizons.

Parent Material

The soils in Foster County formed in glacial drift. As the glacier advanced, it picked up rocks and soil, ground and mixed them, and deposited the material as the ice melted from the receding glacier. Some soils, such as Barnes and Svea soils, formed in unsorted material, or glacial till. Other soils, such as Glyndon and Bearden soils, formed in glaciolacustrine deposits, or glacial material deposited by water in glacial lakes. Still other soils, such as Divide and Sioux soils, formed in glaciofluvial deposits, or material deposited by glacial meltwater.

Climate

Climate has direct and indirect effects on the formation of soils. Precipitation, temperature, and wind directly affect the weathering and reworking of parent material. Climate indirectly affects soil formation through its effects on the amount and kind of vegetation and animal life on or in the soils.

Foster County has a continental, semiarid climate that is characterized by long, cold winters and short, warm summers. The precipitation falls mainly during the growing season but is at times erratic. This type of climate favors the mechanical processes of weathering, such as freezing and thawing, which decrease particle size but result in little change in chemical composition.

In addition to weathering the parent material, precipitation and temperature affect the leaching and redistribution of carbonates and clay particles and the accumulation of organic matter in the soil. Cool temperatures affect the content of organic matter by slowing the decay of plant material and animal remains.

Plant and Animal Life

The soils in Foster County formed mainly under grasses. Grasses provide a plentiful supply of organic matter, which improves the chemical and physical properties of the soil. The fibrous roots of these grasses penetrate the soil to a depth of several feet, making it more porous and more granular. As a result, less water runs off the surface and more moisture is available for increased microbiological activity. The decay of the plants improves the available water capacity, tilth, and fertility of the soil. The decayed organic matter, accumulating over long periods, gives the surface layer its dark color.

Micro-organisms have important effects on soil formation because they feed on undecomposed organic matter and convert it into humus from which plants can obtain nutrients for increased growth. Bacteria and different kinds of fungi attack leaves and other forms of organic matter. Insects, earthworms, and small burrowing animals help to mix the humus with the soil.

Human activities can greatly affect soil formation. Management measures can alter drainage. They also can help to control erosion and thus maintain fertility. Poor management can increase the susceptibility of the soil to erosion, which can result in an unproductive soil.

Relief

The slope of the soils in the county ranges from level to steep. The degree of slope and the shape of the surface influence each soil through their effects on runoff and internal drainage.

In areas where slopes are steep, much of the precipitation is lost as runoff. Therefore, vegetation is sparse and the degree of leaching and profile development is restricted. Buse and Esmond are examples of soils in these areas. Emrick, Svea, and other soils in the lower areas receive additional moisture because of their position on the landscape. Therefore, they are leached to a greater degree than other soils and have a more deeply developed profile and the growth of plants is more luxuriant.

Soils in depressions vary widely in profile development, depending on the degree of wetness. Tonka soils, which are in shallow depressions, exhibit an advanced degree of horizonation because of the alternating wet and dry cycles that occur in the depressions. Because of the increased moisture in the depressions, Tonka soils exhibit properties much like soils in areas of much higher precipitation. Southam soils, which are in the deeper depressions, are nearly continuously wet and have a thick surface layer and carbonates throughout. The profile development in these soils is mostly the result of sedimentary processes rather than soil-forming processes *(4)*.

Time

Soil formation is a very slow process. Much time is required for the processes of soil formation to act on the parent material and to form distinct horizons within the soil profile. Approximately 10,000 to 12,000 years have passed since the glacier receded from Foster County. In geologic terms, the soils in the county are young.

More time has been available for the formation of Cathay soils on glacial till plains than for the formation of La Prairie soils on flood plains. The processes of soil formation have been continually acting on the parent material of the Cathay soils. As a result, these soils have well defined horizons. La Prairie soils continually receive new parent material at the surface as a result of flooding. As a result, they have less distinct horizons.

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Glossary

Alkali (sodic) soil. A soil having so high a degree of alkalinity (pH 8.5 or higher) or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that plant growth is restricted.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Area reclaim (in tables). An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as:

Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	9 to 12
Very high	more than 12

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.

Coarse textured soil. Sand or loamy sand.

Complex, soil. A map unit of two or more kinds of soil in such an intricate pattern or so small in area that it is not practical to map them separately at the selected scale of mapping. The pattern and proportion of the soils are somewhat similar in all areas.

Conservation tillage. A tillage system that does not invert the soil and that leaves a protective amount of crop residue on the surface throughout the year.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are:

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard; little affected by moistening.

Cutbanks cave (in tables). The walls of excavations tend to cave in or slough.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious.

Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically they are wet long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum or periodically receive high rainfall, or both.

Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients.

Eolian soil material. Earthy parent material accumulated through wind action; commonly refers to sandy material in dunes or to loess in blankets on the surface.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of human or animal activities or of a catastrophe in nature, for example, fire, that exposes the surface.

Excess fines (in tables). Excess silt and clay in the soil. The soil is not a source of gravel or sand for construction purposes.

Fallow. Cropland left idle in order to restore productivity through accumulation of moisture. Summer fallow is common in regions of limited rainfall where cereal grains are grown. The soil is tilled for at least one growing season for weed control and decomposition of plant residue.

Fast intake (in tables). The rapid movement of water into the soil.

Fibric soil material (peat). The least decomposed of all organic soil material. Peat contains a large amount of well preserved fiber that is readily identifiable according to botanical origin. Peat has the lowest bulk density and the highest water content at saturation of all organic soil material.

Fine textured soil. Sandy clay, silty clay, or clay.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Frost action (in tables). Freezing and thawing of soil moisture. Frost action can damage roads, buildings and other structures, and plant roots.

Glacial drift (geology). Pulverized and other rock material transported by glacial ice and then deposited. Also, the sorted and unsorted material deposited by streams flowing from glaciers.

Glacial till (geology). Unsorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

Glaciofluvial deposits (geology). Material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice. The deposits are stratified and occur as kames, eskers, deltas, and outwash plains.

Glaciolacustrine deposits. Material ranging from fine clay to sand derived from glaciers and deposited in glacial lakes mainly by glacial meltwater. Many deposits are interbedded or laminated.

Gravel. Rounded or angular fragments of rock up to 3

inches (2 millimeters to 7.6 centimeters) in diameter. An individual piece is a pebble.

Hemic soil material (mucky peat). Organic soil material intermediate in degree of decomposition between the less decomposed fibric and the more decomposed sapric material.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an uppercase letter represents the major horizons. Numbers or lowercase letters that follow represent subdivisions of the major horizons. The major horizons are as follows:

O horizon.—An organic layer of fresh and decaying plant residue.

A horizon.—The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, any plowed or disturbed surface layer.

E horizon.—The mineral horizon in which the main feature is loss of silicate clay, iron, aluminum, or some combination of these.

B horizon.—The mineral horizon below an O, A, or E horizon. The B horizon is in part a layer of transition from the overlying horizon to the underlying C horizon. The B horizon also has distinctive characteristics, such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) granular, prismatic, or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the overlying horizon. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, an Arabic numeral, commonly a 2, precedes the letter C.

Cr horizon.—Soft, consolidated bedrock beneath the soil.

R layer.—Hard, consolidated bedrock beneath the soil. The bedrock commonly underlies a C horizon but can be directly below an A or a B horizon.

Humus. The well decomposed, more or less stable part of the organic matter in mineral soils.

Lake plain. A nearly level area marking the floor of an extinct lake filled with well sorted, stratified sediments.

Large stones (in tables). Rock fragments 3 inches (7.6 centimeters) or more across. Large stones adversely affect the specified use of the soil.

Leaching. The removal of soluble material from soil or other material by percolating water.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Low strength. The soil is not strong enough to support loads.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Miscellaneous area. An area that has little or no natural soil and supports little or no vegetation.

Moderately coarse textured soil. Coarse sandy loam, sandy loam, or fine sandy loam.

Moderately fine textured soil. Clay loam, sandy clay loam, or silty clay loam.

Moraine (geology). An accumulation of earth, stones, and other debris deposited by a glacier. Some types are terminal, lateral, medial, and ground.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—*few, common,* and *many*; size—*fine, medium,* and *coarse*; and contrast—*faint, distinct,* and *prominent.* The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium*, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse*, more than 15 millimeters (about 0.6 inch).

Organic matter. Plant and animal residue in the soil in various stages of decomposition.

Outwash plain. A landform of mainly sandy or coarse textured material of glaciofluvial origin. An outwash plain is commonly smooth; where pitted, it is generally low in relief.

Percs slowly (in tables). The slow movement of water through the soil, adversely affecting the specified use.

Permeability. The quality of the soil that enables water to move downward through the profile. Permeability is measured as the number of inches per hour that water moves downward through the saturated soil. Terms describing permeability are:

Very slow	less than 0.06 inch
Slow	0.06 to 0.2 inch
Moderately slow	0.2 to 0.6 inch
Moderate	0.6 inch to 2.0 inches
Moderately rapid	2.0 to 6.0 inches
Rapid	6.0 to 20 inches
Very rapid	more than 20 inches

Piping (in tables). Formation of subsurface tunnels or pipelike cavities by water moving through the soil.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of

moisture content within which the soil remains plastic.

Ponding. Standing water on soils in closed depressions. Unless the soils are artificially drained, the water can be removed only by percolation or evapotranspiration.

Poor filter (in tables). Because of rapid permeability, the soil may not adequately filter effluent from a waste disposal system.

Productivity, soil. The capability of a soil for producing a specified plant or sequence of plants under specific management.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Reaction, soil. A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degrees of acidity or alkalinity, expressed as pH values, are:

Extremely acid	below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Moderately acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Slightly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Relief. The elevations or inequalities of a land surface, considered collectively.

Rooting depth (in tables). Shallow root zone. The soil is shallow over a layer that greatly restricts roots.

Root shearing. The cutting, tearing, and disruption of plant roots by the hooves of animals in areas that are grazed when the soil is wet and soft.

Runoff. The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Saline-sodic soil. A soil containing enough soluble salts and exchangeable sodium to interfere with the growth of plants.

Saline soil. A soil containing soluble salts in an amount that impairs growth of plants. A saline soil does not contain excess exchangeable sodium.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sapric soil material (muck). The most highly decomposed of all organic soil material. Muck has the least amount of plant fiber, the highest bulk density, and the lowest water content at saturation of all organic soil material.

Seepage (in tables). The movement of water through the soil. Seepage adversely affects the specified use.

Series, soil. A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer or of the substratum. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance. In this survey area the slope classes are:

Level	0 to 1 percent
Level and nearly level	0 to 3 percent
Nearly level	1 to 3 percent
Gently sloping or undulating	3 to 6 percent
Moderately sloping or gently rolling	6 to 9 percent
Strongly sloping or rolling	9 to 15 percent
Moderately steep or hilly	15 to 25 percent
Steep	25 to 35 percent
Very steep	more than 35 percent

Small stones (in tables). Rock fragments less than 3 inches (7.6 centimeters) in diameter. Small stones adversely affect the specified use of the soil.

Sodicity. The degree to which a soil is affected by exchangeable sodium. Sodicity is expressed as a sodium adsorption ratio (SAR) of a saturation extract, or the ratio of Na^{+} to $Ca^{++} + Mg^{++}$. The degrees of sodicity and their respective ratios are:

Slight	less than 13:1
Moderate	13-30:1
Strong	more than 30:1

Soil. A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent

material, as conditioned by relief over periods of time.

Soil depth class. The distance from the top of the soil to the underlying bedrock. The distance, in inches, is expressed as:

Very shallow	less than 10
Shallow	less than 20
Moderately deep	20 to 40
Deep	40 to 60
Very deep	more than 60

Soil separates. Mineral particles less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes, in millimeters, of separates recognized in the United States are as follows:

Very coarse sand	2.0 to 1.0
Coarse sand	1.0 to 0.5
Medium sand	0.5 to 0.25
Fine sand	0.25 to 0.10
Very fine sand	0.10 to 0.05
Silt	0.05 to 0.002
Clay	less than 0.002

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A, E, and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the substratum. The living roots and plant and animal activities are largely confined to the solum.

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter, if rounded or 15 to 24 inches (38 to 60 centimeters) in length if flat.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular. Structureless* soils are either *single grain* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Stubble mulch. Stubble or other crop residue left on the soil or partly worked into the soil. It protects the soil from soil blowing and water erosion after harvest, during preparation of a seedbed for the next crop, and during the early growing period of the new crop.

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. The part of the soil below the solum.

Subsurface layer. An E horizon below an A horizon. If the E horizon is exposed, it is called the surface layer.

Surface layer. An A horizon that is 4 to 9 inches (10 to 24 centimeters) thick.

Surface soil. An A horizon that is 10 inches (25 centimeters) or more thick.

Taxadjuncts. Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use and behavior.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea.

Thin layer (in tables). Otherwise suitable soil material that is too thin for the specified use.

Till plain. An extensive area of nearly level to undulating soils underlain by glacial till.

Tilth, soil. The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Tables

TABLE 1.--TEMPERATURE AND PRECIPITATION

(Recorded in the period 1951-87 at Carrington, North Dakota)

Month	Temperature						Precipitation				
				2 years in 10 will have--				2 years in 10 will have--			
	Average daily maximum	Average daily minimum	Average daily	Maximum temperature higher than--	Minimum temperature lower than--	Average number of growing degree days*	Average	Less than--	More than--	Average number of days with 0.10 inch or more	Average snowfall
	°F	°F	°F	°F	°F	Units	In	In	In		In
January	14.8	-4.8	5.0	44	-32	0	0.62	0.17	0.94	3	8.8
February	21.9	1.8	11.9	48	-26	8	.52	.17	.80	2	6.5
March	33.0	13.1	23.1	63	-18	35	.81	.25	1.21	3	7.8
April	50.9	28.9	39.9	85	8	139	1.54	.35	2.48	4	3.7
May	66.0	40.5	53.3	91	23	421	2.36	1.05	3.39	6	.5
June	74.4	50.7	62.6	95	36	678	3.63	1.91	4.97	7	.0
July	80.9	55.9	68.4	98	43	880	2.83	1.15	4.11	6	.0
August	79.9	53.0	66.5	99	38	822	2.09	.74	3.04	5	.0
September	68.1	42.4	55.3	97	25	459	1.69	.63	2.50	4	.0
October	56.2	32.3	44.3	84	13	190	1.07	.23	1.68	3	1.3
November	36.2	16.6	26.4	69	-13	31	.68	.13	.97	2	5.8
December	21.3	2.4	11.9	51	-28	10	.48	.20	.72	2	6.7
Yearly:											
Average	50.3	28.1	39.1	---	---	---	---	---	---	---	---
Extreme	---	---	---	101	-33	---	---	---	---	---	---
Total	---	---	---	---	---	3,673	18.32	15.33	21.26	47	41.1

* A growing degree day is a unit of heat available for plant growth. It can be calculated by adding the maximum and minimum daily temperatures, dividing the sum by 2, and subtracting the temperature below which growth is minimal for the principal crops in the area (40 degrees F).

TABLE 2.--FREEZE DATES IN SPRING AND FALL

(Recorded in the period 1951-87 at Carrington, North Dakota)

Probability	Temperature		
	24 °F or lower	28 °F or lower	32 °F or lower
Last freezing temperature in spring:			
1 year in 10 later than--	May 11	May 18	May 25
2 years in 10 later than--	May 6	May 14	May 22
5 years in 10 later than--	Apr. 24	May 4	May 14
First freezing temperature in fall:			
1 year in 10 earlier than--	Sept. 30	Sept. 14	Sept. 9
2 years in 10 earlier than--	Oct. 6	Sept. 20	Sept. 14
5 years in 10 earlier than--	Oct. 17	Oct. 1	Sept. 23

TABLE 3.--GROWING SEASON

(Recorded in the period 1951-87 at Carrington, North Dakota)

Probability	Daily minimum temperature during growing season		
	Higher than 24 °F	Higher than 28 °F	Higher than 32 °F
	Days	Days	Days
9 years in 10	150	126	112
8 years in 10	159	134	118
5 years in 10	175	149	131
2 years in 10	191	164	143
1 year in 10	199	172	149

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
1	Southam silt loam	5,750	1.4
2	Parnell silty clay loam	9,190	2.2
3	Tonka silt loam	2,760	0.7
4	Manfred loam	3,320	0.8
7	Colvin silt loam, wet	1,320	0.3
8	Minnewaukan loamy fine sand	600	0.1
9	Lallie, saline-Minnewaukan complex	720	0.2
10	Colvin and Arveson, loamy substratum, soils, saline	11,090	2.7
17	Vallers and Hamerly loams, saline	20,250	4.9
21	Svea loam, 0 to 2 percent slopes	2,230	0.5
22	Svea-Barnes loams, 0 to 3 percent slopes	16,260	3.9
23	Hamerly-Wyard loams, 0 to 3 percent slopes	38,370	9.3
24	Hamerly-Parnell complex, 0 to 3 percent slopes	11,570	2.8
25B	Barnes-Maddock, loamy substratum, complex, 3 to 6 percent slopes	2,680	0.6
26B	Barnes-Svea loams, 3 to 6 percent slopes	14,230	3.4
27B	Barnes-Buse loams, 3 to 6 percent slopes	19,830	4.8
27C	Barnes-Buse loams, 6 to 9 percent slopes	9,860	2.4
28F	Barnes-Buse loams, 15 to 35 percent slopes	1,880	0.5
29D	Buse-Svea loams, 9 to 15 percent slopes	3,640	0.9
30C	Barnes-Maddock-Swenoda complex, 6 to 9 percent slopes	1,890	0.5
31	Fram-Parnell complex, 0 to 3 percent slopes	4,450	1.1
33	Fram-Wyard loams, 0 to 3 percent slopes	54,820	13.3
36	Heimdal-Emrick loams, 0 to 3 percent slopes	44,200	10.7
36B	Heimdal-Emrick loams, 3 to 6 percent slopes	17,900	4.3
37B	Heimdal-Esmond loams, 3 to 6 percent slopes	16,200	3.9
37C	Heimdal-Esmond loams, 6 to 9 percent slopes	9,310	2.2
38F	Heimdal-Esmond loams, 15 to 35 percent slopes	5,860	1.4
39D	Heimdal-Esmond loams, 9 to 15 percent slopes	4,670	1.1
41B	Embden fine sandy loam, 0 to 6 percent slopes	4,150	1.0
42	Wyndmere-Arveson complex, loamy substratum, 0 to 3 percent slopes	3,120	0.8
51	Bearden silty clay loam, sandy substratum	2,350	0.6
52	Glyndon loam, 0 to 2 percent slopes	1,110	0.3
60	Cathay-Heimdal loams, 1 to 3 percent slopes	9,250	2.3
60B	Heimdal-Cathay loams, 3 to 6 percent slopes	2,520	0.6
61	Larson-Cathay loams, 0 to 2 percent slopes	9,440	2.3
62	Miranda-Larson loams, 0 to 2 percent slopes	3,370	0.8
67	Letcher fine sandy loam, 0 to 3 percent slopes	680	0.2
71	Spottswood loam, 0 to 3 percent slopes	1,380	0.3
72	Divide loam, 0 to 3 percent slopes	5,380	1.3
77B	Arvilla sandy loam, 0 to 6 percent slopes	4,920	1.2
78C	Sioux-Arvilla complex, 1 to 9 percent slopes	2,850	0.7
78F	Coe-Heimdal loams, 9 to 35 percent slopes	1,300	0.3
80	Towner-Barnes sandy loams, 0 to 3 percent slopes	1,010	0.2
81	Hecla fine sandy loam, loamy substratum, 0 to 3 percent slopes	3,140	0.8
82B	Towner loamy fine sand, 0 to 6 percent slopes	1,930	0.5
84B	Lohnes loamy coarse sand, 0 to 6 percent slopes	1,360	0.3
86B	Maddock loamy fine sand, 0 to 6 percent slopes	3,450	0.8
89D	Maddock-Barnes-Towner complex, 6 to 15 percent slopes	1,840	0.4
90	Ulen-Hecla fine sandy loams, 0 to 2 percent slopes	1,360	0.3
91B	Swenoda fine sandy loam, 0 to 6 percent slopes	4,270	1.0
95	Colvin and La Prairie soils, channeled	3,710	0.9
96	La Prairie loam	1,740	0.4
99	Pits, sand and gravel	170	*
102	Kratka fine sandy loam	760	0.2
	Water	2,490	0.6
	Total	413,900	100.0

* Less than 0.1 percent.

TABLE 5.--YIELDS PER ACRE OF CROPS

(Yields are those that can be expected under a high level of management. For poorly drained and very poorly drained soils, however, the yields are those expected in undrained areas. Absence of a yield indicates that the soil is not suited to the crop or the crop generally is not grown on the soil)

Soil name and map symbol	Spring wheat	Oats	Barley	Flax	Sunflowers	Bromegrass-alfalfa hay
	Bu	Bu	Bu	Bu	Lbs	Tons
1. Southam						
2---------- Parnell	8	17	13	4	400	2.8
3---------- Tonka	17	36	27	8	850	2.8
4---------- Manfred	---	---	---	---	---	1.6
7---------- Colvin	4	9	7	2	200	2.4
8---------- Minnewaukan	11	23	18	5	550	2.8
9---------- Lallie-Minnewaukan	---	---	---	---	---	2.3
10---------- Colvin and Arveson	10	20	16	5	500	2.1
17---------- Vallers and Hamerly	12	26	20	6	600	2.1
21---------- Svea	37	78	60	18	1,850	2.8
22---------- Svea-Barnes	36	77	59	18	1,800	2.7
23---------- Hamerly-Wyard	33	70	53	16	1,650	2.4
24---------- Hamerly-Parnell	27	57	44	13	1,350	2.4
25B---------- Barnes-Maddock	23	49	38	12	1,150	2.4
26B---------- Barnes-Svea	32	68	52	16	1,600	2.6
27B---------- Barnes-Buse	28	59	45	14	1,400	2.2
27C---------- Barnes-Buse	23	49	38	12	1,150	2.1
28F. Barnes-Buse						
29D---------- Buse-Svea	---	---	---	---	---	1.9
30C---------- Barnes-Maddock-Swenoda	20	43	33	10	1,000	2.3

TABLE 5.--YIELDS PER ACRE OF CROPS--Continued

Soil name and map symbol	Spring wheat	Oats	Barley	Flax	Sunflowers	Bromegrass-alfalfa hay
	Bu	Bu	Bu	Bu	Lbs	Tons
31--Fram-Parnell	26	54	42	13	1,300	2.4
33--Fram-Wyard	33	71	54	17	1,650	2.4
36--Heimdal-Emrick	33	70	53	16	1,650	2.7
36B--Heimdal-Emrick	29	61	47	14	1,450	2.6
37B--Heimdal-Esmond	25	54	41	13	1,250	2.2
37C--Heimdal-Esmond	22	47	36	11	1,100	2.1
38F. Heimdal-Esmond						
39D--Heimdal-Esmond	11	23	18	6	550	1.9
41B--Embden	27	57	44	13	1,350	2.1
42--Wyndmere-Arveson	25	54	41	13	1,250	2.4
51--Bearden	36	77	59	18	1,800	2.3
52--Glyndon	36	76	58	18	1,800	2.3
60--Cathay-Heimdal	30	64	49	15	1,500	2.0
60B--Heimdal-Cathay	29	61	47	14	1,450	2.2
61--Larson-Cathay	20	43	33	10	1,000	1.4
62--Miranda-Larson	---	---	---	---	---	1.1
67--Letcher	13	28	21	7	650	1.4
71--Spottswood	26	55	42	13	1,300	2.6
72--Divide	25	54	41	13	1,250	2.3
77B--Arvilla	17	36	27	8	850	1.8
78C--Sioux-Arvilla	---	---	---	---	---	1.2

TABLE 5.--YIELDS PER ACRE OF CROPS--Continued

Soil name and map symbol	Spring wheat	Oats	Barley	Flax	Sunflowers	Bromegrass-alfalfa hay
	Bu	Bu	Bu	Bu	Lbs	Tons
78F. Coe-Heimdal						
80---------- Towner-Barnes	28	60	46	14	1,400	2.3
81---------- Hecla	24	50	38	12	1,200	2.1
82B---------- Towner	20	43	33	10	1,000	1.8
84B---------- Lohnes	15	31	24	7	750	1.8
86B---------- Maddock	17	36	27	8	850	1.8
89D---------- Maddock-Barnes-Towner	---	---	---	---	---	1.8
90---------- Ulen-Hecla	24	50	38	12	1,200	2.2
91B---------- Swenoda	28	60	46	14	1,400	2.1
95---------- Colvin and La Prairie	---	---	---	---	---	2.8
96---------- La Prairie	38	82	62	19	1,900	2.8
99*. Pits						
102---------- Kratka	12	26	20	6	600	2.8

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 6.--RANGELAND PRODUCTIVITY

Soil name and map symbol	Range site	Potential annual production for kind of growing season		
		Favorable	Average	Unfavorable
		Lb/acre	Lb/acre	Lb/acre
1 Southam	None assigned	---	---	---
2 Parnell	Wetland	7,000	6,600	6,000
3 Tonka	Wet Meadow	5,000	4,500	4,000
4 Manfred	Saline Lowland	3,500	3,200	2,800
7 Colvin	Wetland	7,000	6,600	6,000
8 Minnewaukan	Subirrigated	4,800	4,400	3,900
9*:				
Lallie	Saline Lowland	3,400	3,000	2,600
Minnewaukan	Subirrigated	4,800	4,400	3,900
10*:				
Colvin	Saline Lowland	3,500	3,200	2,800
Arveson	Saline Lowland	---	---	---
17*:				
Vallers	Saline Lowland	4,000	3,500	3,000
Hamerly	Saline Lowland	3,500	3,200	2,800
21 Svea	Overflow	4,000	3,600	3,100
22*:				
Svea	Overflow	4,000	3,600	3,100
Barnes	Silty	3,200	2,700	2,300
23*:				
Hamerly	Limy Subirrigated	4,800	4,200	3,600
Wyard	Overflow	4,000	3,600	3,100
24*:				
Hamerly	Limy Subirrigated	4,800	4,200	3,600
Parnell	Wetland	7,000	6,600	6,000
25B*:				
Barnes	Silty	3,200	2,700	2,300
Maddock	Sandy	3,200	2,800	2,400
26B*:				
Barnes	Silty	3,200	2,700	2,300

See footnote at end of table.

TABLE 6.--RANGELAND PRODUCTIVITY--Continued

Soil name and map symbol	Range site	Potential annual production for kind of growing season		
		Favorable	Average	Unfavorable
		Lb/acre	Lb/acre	Lb/acre
26B*:				
Svea	Silty	3,500	3,000	2,600
27B*, 27C*, 28F*:				
Barnes	Silty	3,200	2,700	2,300
Buse	Thin Upland	2,800	2,500	2,100
29D*:				
Buse	Thin Upland	2,800	2,500	2,100
Svea	Silty	3,400	2,900	2,500
30C*:				
Barnes	Silty	3,200	2,700	2,300
Maddock	Sandy	3,200	2,800	2,400
Swenoda	Sandy	3,200	2,800	2,400
31*:				
Fram	Limy Subirrigated	4,800	4,200	3,600
Parnell	Wetland	7,000	6,600	6,000
33*:				
Fram	Limy Subirrigated	4,800	4,200	3,600
Wyard	Overflow	4,000	3,600	3,100
36*:				
Heimdal	Silty	3,200	2,700	2,300
Emrick	Overflow	3,900	3,500	3,000
36B*:				
Heimdal	Silty	3,200	2,700	2,300
Emrick	Silty	3,400	2,900	2,500
37B*, 37C*, 38F*, 39D*:				
Heimdal	Silty	3,200	2,700	2,300
Esmond	Thin Upland	2,800	2,500	2,100
41B Embden	Sandy	3,200	2,800	2,400
42*:				
Wyndmere	Limy Subirrigated	4,800	4,200	3,600
Arveson	Subirrigated	4,800	4,400	3,900
51 Bearden	Limy Subirrigated	4,800	4,200	3,600
52 Glyndon	Limy Subirrigated	4,800	4,200	3,600
60*:				
Cathay	Clayey	2,800	2,400	2,000

See footnote at end of table.

TABLE 6.--RANGELAND PRODUCTIVITY--Continued

Soil name and map symbol	Range site	Potential annual production for kind of growing season		
		Favorable	Average	Unfavorable
		Lb/acre	Lb/acre	Lb/acre
60*:				
Heimdal	Silty	3,200	2,700	2,300
60B*:				
Heimdal	Silty	3,200	2,700	2,300
Cathay	Clayey	2,800	2,400	2,000
61*:				
Larson	Claypan	2,300	2,000	1,600
Cathay	Clayey	2,800	2,400	2,000
62*:				
Miranda	Thin Claypan	1,300	1,100	900
Larson	Claypan	2,300	2,000	1,600
67 Letcher	Sandy Claypan	3,800	2,800	1,800
71 Spottswood	Silty	3,200	2,700	2,300
72 Divide	Limy Subirrigated	4,800	4,200	3,600
77B Arvilla	Shallow to Gravel	2,100	1,900	1,600
78C*:				
Sioux	Very Shallow	1,200	1,000	800
Arvilla	Shallow to Gravel	2,100	1,900	1,600
78F*:				
Coe	Very Shallow	1,200	1,000	800
Heimdal	Silty	3,200	2,700	2,300
80*:				
Towner	Sandy	3,300	2,800	2,300
Barnes	Silty	3,200	2,700	2,300
81 Hecla	Sandy	3,500	3,000	2,600
82B Towner	Sands	3,300	2,900	2,500
84B Lohnes	Sands	3,000	2,600	2,200
86B Maddock	Sands	3,300	2,900	2,500
89D*:				
Maddock	Sands	3,300	2,900	2,500
Barnes	Silty	3,200	2,700	2,300

See footnote at end of table.

TABLE 6.--RANGELAND PRODUCTIVITY--Continued

Soil name and map symbol	Range site	Potential annual production for kind of growing season		
		Favorable	Average	Unfavorable
		Lb/acre	Lb/acre	Lb/acre
89D*:				
Towner	Sands	3,300	2,900	2,500
90*:				
Ulen	Limy Subirrigated	4,800	4,200	3,600
Hecla	Sandy	3,400	3,000	2,600
91B	Sandy	3,200	2,800	2,400
Swenoda				
95*:				
Colvin	Subirrigated	5,000	4,500	4,000
La Prairie	Overflow	4,200	3,700	3,200
96	Silty	3,500	3,000	2,600
La Prairie				
99*	None assigned	---	---	---
Pits				
102	Subirrigated	4,800	4,400	3,900
Kratka				

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS

(The symbol < means less than; > means more than. Absence of an entry indicates that trees generally do not grow to the given height on that soil)

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
1. Southam					
2---Parnell	American plum	Common chokecherry, redosier dogwood, lilac, Siberian peashrub, eastern redcedar.	Siberian crabapple, Black Hills spruce, green ash.	Golden willow	Eastern cottonwood.
3---Tonka	---	Eastern redcedar, common chokecherry, lilac, American plum, redosier dogwood, Siberian peashrub.	Green ash, Siberian crabapple, Black Hills spruce.	Golden willow	Eastern cottonwood.
4. Manfred					
7---Colvin	---	American plum, Siberian peashrub, eastern redcedar, redosier dogwood, lilac.	Green ash, Black Hills spruce, Siberian crabapple.	Golden willow	Eastern cottonwood, Siberian elm.
8---Minnewaukan	American plum	Lilac, Siberian peashrub, eastern redcedar, redosier dogwood, common chokecherry.	Siberian crabapple, green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
9*: Lallie.					
Minnewaukan	American plum	Lilac, Siberian peashrub, eastern redcedar, redosier dogwood, common chokecherry.	Siberian crabapple, green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
10*:					
Colvin	Silver buffaloberry, Siberian peashrub.	---	Russian-olive, green-ash, Siberian elm.	---	---
Arveson	Siberian peashrub, silver buffaloberry.	---	Siberian elm, green ash, Russian-olive.	---	---

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
17*:					
Vallers	Siberian peashrub, silver buffaloberry.	---	Siberian elm, green ash, Russian-olive.	---	---
Hamerly	Silver buffaloberry, Siberian peashrub.	---	Siberian elm, Russian-olive, green ash.	---	---
21 Svea	---	Redosier dogwood, ponderosa pine, common chokecherry, Siberian peashrub, American plum.	Black Hills spruce, blue spruce, green ash, eastern redcedar.	Golden willow	Eastern cottonwood.
22*:					
Svea	---	Redosier dogwood, ponderosa pine, common chokecherry, Siberian peashrub, American plum.	Black Hills spruce, blue spruce, green ash, eastern redcedar.	Golden willow	Eastern cottonwood.
Barnes	---	Eastern redcedar, American plum, lilac, Siberian peashrub, redosier dogwood.	Siberian crabapple, bur oak, green ash, ponderosa pine, Black Hills spruce, Russian-olive.	---	---
23*:					
Hamerly	---	Redosier dogwood, ponderosa pine, Siberian peashrub, Peking cotoneaster, eastern redcedar, American plum, common chokecherry.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
Wyard	---	Siberian peashrub, ponderosa pine, American plum, Peking cotoneaster, eastern redcedar, redosier dogwood, common chokecherry.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
24*:					
Hamerly	---	Redosier dogwood, ponderosa pine, Siberian peashrub, Peking cotoneaster, eastern redcedar, American plum, common chokecherry.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
Parnell	American plum	Common chokecherry, redosier dogwood, lilac, Siberian peashrub, eastern redcedar.	Siberian crabapple, Black Hills spruce, green ash.	Golden willow	Eastern cottonwood.
25B*:					
Barnes	---	Eastern redcedar, American plum, lilac, Siberian peashrub, redosier dogwood.	Siberian crabapple, bur oak, green ash, ponderosa pine, Black Hills spruce, Russian-olive.	---	---
Maddock	---	Silver buffaloberry, common chokecherry, Siberian peashrub, eastern redcedar, lilac, American plum, Siberian crabapple.	Bur oak, green ash, ponderosa pine, Russian-olive.	---	---
26B*:					
Barnes	---	Eastern redcedar, American plum, lilac, Siberian peashrub, redosier dogwood.	Siberian crabapple, bur oak, green ash, ponderosa pine, Black Hills spruce, Russian-olive.	---	---
Svea	---	Redosier dogwood, ponderosa pine, common chokecherry, Siberian peashrub, American plum.	Black Hills spruce, blue spruce, green ash, eastern redcedar.	Golden willow	Eastern cottonwood.

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
27B*, 27C*:					
Barnes	---	Eastern redcedar, American plum, lilac, Siberian peashrub, redosier dogwood.	Siberian crabapple, bur oak, green ash, ponderosa pine, Black Hills spruce, Russian-olive.	---	---
Buse	Siberian peashrub	Green ash, eastern redcedar, ponderosa pine, Russian-olive, Rocky Mountain juniper.	Siberian elm	---	---
28F*:					
Barnes.					
Buse.					
29D*:					
Buse.					
Svea	---	Lilac, Siberian peashrub, redosier dogwood, eastern redcedar, American plum.	Bur oak, Siberian crabapple, green ash, ponderosa pine, Black Hills spruce, Russian-olive.		
30C*:					
Barnes	---	Eastern redcedar, American plum, lilac, Siberian peashrub, redosier dogwood.	Siberian crabapple, bur oak, green ash, ponderosa pine, Black Hills spruce, Russian-olive.	---	---
Maddock	---	Lilac, silver buffaloberry, common chokecherry, Siberian peashrub, eastern redcedar, Siberian crabapple, American plum.	Green ash, ponderosa pine, Russian-olive, bur oak.	---	---
Swenoda	---	Eastern redcedar, redosier dogwood, American plum, Siberian peashrub, lilac.	Ponderosa pine, Black Hills spruce, green ash, Russian-olive, bur oak, Siberian crabapple.	---	---

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
31*:					
Fram	---	Redosier dogwood, ponderosa pine, Siberian peashrub, American plum, eastern redcedar, Peking cotoneaster, common chokecherry.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
Parnell	American plum	Common chokecherry, redosier dogwood, lilac, Siberian peashrub, eastern redcedar.	Siberian crabapple, Black Hills spruce, green ash.	Golden willow	Eastern cottonwood.
33*:					
Fram	---	Redosier dogwood, ponderosa pine, Siberian peashrub, American plum, eastern redcedar, Peking cotoneaster, common chokecherry.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
Wyard	---	Siberian peashrub, ponderosa pine, American plum, Peking cotoneaster, eastern redcedar, redosier dogwood, common chokecherry.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
36*, 36B*:					
Heimdal	---	Eastern redcedar, lilac, American plum, Siberian peashrub, redosier dogwood.	Siberian crabapple, bur oak, green ash, ponderosa pine, Black Hills spruce, Russian-olive.	---	---
Emrick	---	Siberian peashrub, ponderosa pine, American plum, Peking cotoneaster, eastern redcedar, redosier dogwood, common chokecherry.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
37B*, 37C*:					
Heimdal	---	Eastern redcedar, plum, Siberian peashrub, redosier dogwood.	Siberian oak, green ash, ponderosa pine, Black Hills spruce, Russian-olive.	---	---
Esmond	Siberian peashrub	Green ash, ponderosa pine, Russian-olive, eastern redcedar, Rocky Mountain juniper.	Siberian elm	---	---
38F*:					
Heimdal.					
Esmond.					
39D*:					
Heimdal	---	Eastern redcedar, lilac, American plum, Siberian peashrub, redosier dogwood.	Siberian crabapple, bur oak, green ash, ponderosa pine, Black Hills spruce, Russian-olive.	---	---
Esmond.					
41B	---	Peking cotoneaster, ponderosa pine, eastern redcedar, redosier dogwood, common chokecherry, Siberian peashrub, American plum.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
Embden					
42*:					
Wyndmere	---	Common chokecherry, American plum, ponderosa pine, Siberian peashrub, Peking cotoneaster, eastern redcedar, Tatarian honeysuckle, redosier dogwood.	Black Hills spruce, green ash.	Golden willow	Eastern cottonwood.

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
42*:					
Arveson	American plum	Common chokecherry, redosier dogwood, lilac, Siberian peashrub, eastern redcedar.	Siberian crabapple, Black Hills spruce, green ash.	Golden willow	Eastern cottonwood.
51 Bearden	---	Redosier dogwood, ponderosa pine, eastern redcedar, common chokecherry, Siberian peashrub, Peking cotoneaster, American plum.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
52 Glyndon	---	Common chokecherry, American plum, ponderosa pine, Siberian peashrub, Peking cotoneaster, eastern redcedar, redosier dogwood.	Black Hills spruce, green ash.	Golden willow	Eastern cottonwood.
60*:					
Cathay	---	Common chokecherry, eastern redcedar, Peking cotoneaster, Russian-olive, silver buffaloberry, Siberian peashrub, lilac.	Siberian elm, green ash, ponderosa pine, Siberian crabapple.	---	---
Heimdal	---	Eastern redcedar, lilac, American plum, Siberian peashrub, redosier dogwood.	Siberian crabapple, bur oak, green ash, ponderosa pine, Black Hills spruce, Russian-olive.	---	---
60B*:					
Heimdal	---	Eastern redcedar, lilac, American plum, Siberian peashrub, redosier dogwood.	Siberian crabapple, bur oak, green ash, ponderosa pine, Black Hills spruce, Russian-olive.	---	---

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
60B*:					
Cathay	---	Common chokecherry, eastern redcedar, Peking cotoneaster, Russian-olive, silver buffaloberry, Siberian peashrub, lilac.	Siberian elm, green ash, ponderosa pine, Siberian crabapple.	---	---
61*:					
Larson	Rocky Mountain juniper, Siberian peashrub, silver buffaloberry.	Siberian elm, green ash, ponderosa pine, Russian-olive, eastern redcedar.	---	---	---
Cathay	---	Common chokecherry, eastern redcedar, Peking cotoneaster, Russian-olive, silver buffaloberry, Siberian peashrub, lilac.	Siberian elm, green ash, ponderosa pine, Siberian crabapple.	---	---
62*:					
Miranda.					
Larson	Rocky Mountain juniper, Siberian peashrub, silver buffaloberry.	Siberian elm, green ash, ponderosa pine, Russian-olive, eastern redcedar.	---	---	---
67---------- Letcher	Silver buffaloberry, Siberian peashrub, Rocky Mountain juniper.	Eastern redcedar, Russian-olive, ponderosa pine, green ash, Siberian elm.	---	---	---
71---------- Spottswood	---	Eastern redcedar, lilac, American plum, redosier dogwood, Siberian peashrub.	Ponderosa pine, Russian-olive, green ash, bur oak, Black Hills spruce, Siberian crabapple.	---	---
72---------- Divide	---	Redosier dogwood, ponderosa pine, Siberian peashrub, Peking cotoneaster, eastern redcedar, American plum, common chokecherry.	Green ash, Black Hills spruce.	Golden willow-----	Eastern cottonwood.

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
77B---------- Arvilla	Silver buffaloberry, Siberian peashrub, lilac.	Green ash, Russian-olive, Siberian crabapple, eastern redcedar, Rocky Mountain juniper, common chokecherry.	Ponderosa pine----	---	---
78C*: Sioux.					
Arvilla----------	Silver buffaloberry, Siberian peashrub, lilac.	Green ash, Russian-olive, Siberian crabapple, eastern redcedar, Rocky Mountain juniper, common chokecherry.	Ponderosa pine----	---	---
78F*: Coe.					
Heimdal.					
80*: Towner----------	---	Eastern redcedar, Siberian crabapple, common chokecherry, American plum, lilac, Siberian peashrub, silver buffaloberry.	Green ash, ponderosa pine, Russian-olive, bur oak.	---	---
Barnes----------	---	Eastern redcedar, American plum, lilac, Siberian peashrub, redosier dogwood.	Siberian crabapple, bur oak, green ash, ponderosa pine, Black Hills spruce, Russian-olive.	---	---
81---------- Hecla	---	Common chokecherry, American plum, ponderosa pine, Siberian peashrub, Peking cotoneaster, eastern redcedar, redosier dogwood.	Black Hills spruce, green ash.	Golden willow-----	Eastern cottonwood.

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
82B---------- Towner	---	Lilac, eastern redcedar, Siberian peashrub, common chokecherry, Siberian crabapple, American plum, silver buffaloberry.	Ponderosa pine, green ash, Russian-olive, bur oak.	---	---
84B---------- Lohnes	---	Rocky Mountain juniper, ponderosa pine, eastern redcedar.	---	---	---
86B---------- Maddock	---	Silver buffaloberry, common chokecherry, Siberian peashrub, eastern redcedar, lilac, American plum, Siberian crabapple.	Bur oak, green ash, ponderosa pine, Russian-olive.	---	---
89D*:					
Maddock.					
Barnes----------	---	Eastern redcedar, American plum, lilac, Siberian peashrub, redosier dogwood.	Siberian crabapple, bur oak, green ash, ponderosa pine, Black Hills spruce, Russian-olive.	---	---
Towner.					
90*:					
Ulen----------	---	Common chokecherry, American plum, ponderosa pine, Siberian peashrub, Peking cotoneaster, eastern redcedar, redosier dogwood.	Black Hills spruce, green ash.	Golden willow-----	Eastern cottonwood.
Hecla----------	---	Common chokecherry, American plum, ponderosa pine, Siberian peashrub, Peking cotoneaster, eastern redcedar, redosier dogwood.	Black Hills spruce, green ash.	Golden willow-----	Eastern cottonwood.

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
91B---------- Swenoda	---	Common chokecherry, American plum, ponderosa pine, Siberian peashrub, Peking cotoneaster, eastern redcedar, redosier dogwood.	Black Hills spruce, green ash.	Golden willow-----	Eastern cottonwood.
95*: Colvin.					
La Prairie-------	---	Ponderosa pine, Peking cotoneaster, redosier dogwood, eastern redcedar, common chokecherry, Siberian peashrub, American plum.	Black Hills spruce, green ash.	Golden willow-----	Eastern cottonwood.
96---------- La Prairie	---	Common chokecherry, American plum, ponderosa pine, Siberian peashrub, Peking cotoneaster, eastern redcedar, Tatarian honeysuckle, redosier dogwood.	Black Hills spruce, green ash.	Golden willow-----	Eastern cottonwood.
99*. Pits					
102---------- Kratka	---	Common chokecherry, redosier dogwood, lilac, Siberian peashrub, eastern redcedar, American plum.	Siberian crabapple, Black Hills spruce, green ash.	Golden willow-----	Eastern cottonwood.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 8.--RECREATIONAL DEVELOPMENT

(Some terms that describe restrictive soil features are defined in the "Glossary." See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated)

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
1 Southam	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
2 Parnell	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
3 Tonka	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
4 Manfred	Severe: ponding, excess sodium.	Severe: ponding, excess sodium.	Severe: ponding, excess sodium.	Severe: ponding.
7 Colvin	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
8 Minnewaukan	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
9*: Lallie	Severe: ponding.	Severe: ponding, excess salt.	Severe: ponding.	Severe: ponding.
Minnewaukan	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
10*: Colvin	Severe: wetness, excess salt.	Severe: wetness, excess salt.	Severe: wetness, excess salt.	Severe: wetness.
Arveson	Severe: wetness, excess salt.	Severe: wetness, excess salt.	Severe: wetness, excess salt.	Severe: wetness.
17*: Vallers	Severe: wetness, excess salt.	Severe: wetness, excess salt.	Severe: wetness, excess salt.	Severe: wetness.
Hamerly	Severe: excess salt.	Severe: excess salt.	Severe: excess salt.	Slight.
21 Svea	Slight	Slight	Moderate: small stones.	Slight.
22*: Svea	Slight	Slight	Moderate: small stones.	Slight.
Barnes	Slight	Slight	Moderate: small stones.	Slight.

See footnote at end of table.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
23*:				
Hamerly	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Slight.
Wyard	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.
24*:				
Hamerly	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Slight.
Parnell	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
25B*:				
Barnes	Slight	Slight	Moderate: slope, small stones.	Slight.
Maddock	Slight	Slight	Moderate: slope.	Slight.
26B*:				
Barnes	Slight	Slight	Moderate: slope, small stones.	Slight.
Svea	Slight	Slight	Moderate: slope, small stones.	Slight.
27B*:				
Barnes	Slight	Slight	Moderate: slope, small stones.	Slight.
Buse	Slight	Slight	Moderate: slope, small stones.	Slight.
27C*:				
Barnes	Slight	Slight	Severe: slope.	Slight.
Buse	Slight	Slight	Severe: slope.	Slight.
28F*:				
Barnes	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
Buse	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
29D*:				
Buse	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.

See footnote at end of table.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
29D*:				
Svea	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
30C*:				
Barnes	Slight	Slight	Severe: slope.	Slight.
Maddock	Slight	Slight	Severe: slope.	Slight.
Swenoda	Slight	Slight	Severe: slope.	Slight.
31*:				
Fram	Moderate: wetness.	Moderate: wetness.	Moderate: wetness.	Slight.
Parnell	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
33*:				
Fram	Moderate: wetness.	Moderate: wetness.	Moderate: wetness.	Slight.
Wyard	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.
36*:				
Heimdal	Slight	Slight	Slight	Slight.
Emrick	Slight	Slight	Slight	Slight.
36B*:				
Heimdal	Slight	Slight	Moderate: slope.	Slight.
Emrick	Slight	Slight	Moderate: slope.	Slight.
37B*:				
Heimdal	Slight	Slight	Moderate: slope.	Slight.
Esmond	Slight	Slight	Moderate: slope.	Slight.
37C*:				
Heimdal	Slight	Slight	Severe: slope.	Slight.
Esmond	Slight	Slight	Severe: slope.	Slight.
38F*:				
Heimdal	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
Esmond	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.

See footnote at end of table.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
39D*:				
Heimdal	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
Esmond	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
41B Embden	Slight	Slight	Moderate: slope.	Slight.
42*:				
Wyndmere	Moderate: wetness.	Moderate: wetness.	Moderate: wetness.	Slight.
Arveson	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
51 Bearden	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Slight.
52 Glyndon	Slight	Slight	Slight	Slight.
60*:				
Cathay	Severe: excess sodium.	Severe: excess sodium.	Severe: excess sodium.	Slight.
Heimdal	Slight	Slight	Moderate: slope.	Slight.
60B*:				
Heimdal	Slight	Slight	Moderate: slope.	Slight.
Cathay	Severe: excess sodium.	Severe: excess sodium.	Severe: excess sodium.	Slight.
61*:				
Larson	Severe: excess sodium.	Severe: excess sodium.	Severe: excess sodium.	Slight.
Cathay	Severe: excess sodium.	Severe: excess sodium.	Severe: excess sodium.	Slight.
62*:				
Miranda	Severe: excess sodium.	Severe: excess sodium.	Severe: excess sodium.	Slight.
Larson	Severe: excess sodium.	Severe: excess sodium.	Severe: excess sodium.	Slight.
67 Letcher	Severe: excess sodium.	Severe: excess sodium.	Severe: excess sodium.	Slight.
71 Spottswood	Slight	Slight	Slight	Slight.
72 Divide	Slight	Slight	Slight	Slight.

See footnote at end of table.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
77B Arvilla	Slight	Slight	Moderate: slope.	Slight.
78C*: Sioux	Slight	Slight	Moderate: slope, small stones.	Slight.
Arvilla	Slight	Slight	Moderate: slope.	Slight.
78F*: Coe	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
Heimdal	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
80*: Towner	Slight	Slight	Slight	Slight.
Barnes	Slight	Slight	Moderate: small stones.	Slight.
81 Hecla	Slight	Slight	Slight	Slight.
82B Towner	Moderate: too sandy.	Moderate: too sandy.	Moderate: slope, too sandy.	Moderate: too sandy.
84B Lohnes	Moderate: too sandy.	Moderate: too sandy.	Moderate: slope.	Moderate: too sandy.
86B Maddock	Moderate: too sandy.	Moderate: too sandy.	Moderate: slope, too sandy.	Moderate: too sandy.
89D*: Maddock	Moderate: slope, too sandy.	Moderate: slope, too sandy.	Severe: slope.	Moderate: too sandy.
Barnes	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
Towner	Moderate: too sandy.	Moderate: too sandy.	Severe: slope.	Moderate: too sandy.
90*: Ulen	Slight	Slight	Slight	Slight.
Hecla	Slight	Slight	Slight	Slight.
91B Swenoda	Slight	Slight	Moderate: slope.	Slight.
95*: Colvin	Severe: flooding, wetness.	Severe: wetness.	Severe: wetness, flooding.	Severe: wetness.

See footnote at end of table.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
95*: La Prairie	Severe: flooding.	Slight	Moderate: flooding.	Slight.
96 La Prairie	Severe: flooding.	Slight	Slight	Slight.
99*. Pits				
102 Kratka	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 9.--WILDLIFE HABITAT

(See text for definitions of "good," "fair," "poor," and "very poor." Absence of an entry indicates that the soil was not rated)

Soil name and map symbol	Potential for habitat elements						Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Shrubs	Wetland plants	Shallow water areas	Openland wildlife	Wetland wildlife	Rangeland wildlife
1---------- Southam	Very poor	Very poor	Very poor	Very poor	Good	Good	Very poor	Good	Very poor.
2---------- Parnell	Very poor	Poor	Poor	Poor	Good	Good	Poor	Good	Poor.
3---------- Tonka	Poor	Fair	Fair	Poor	Good	Good	Poor	Good	Poor.
4---------- Manfred	Poor	Fair	Fair	Poor	Good	Good	Poor	Good	Poor.
7---------- Colvin	Very poor	Poor	Poor	Poor	Good	Good	Poor	Good	Poor.
8---------- Minnewaukan	Poor	Poor	Fair	Fair	Fair	Very poor	Poor	Poor	Fair.
9*:									
Lallie----------	Poor	Poor	Poor	Very poor	Poor	Good	Poor	Fair	Very poor.
Minnewaukan-------	Poor	Poor	Fair	Fair	Fair	Very poor	Poor	Poor	Fair.
10*:									
Colvin----------	Poor	Fair	Poor	Fair	Good	Good	Poor	Good	Poor.
Arveson----------	Poor	Fair	Very poor	Very poor	Good	Good	Poor	Good	Very poor.
17*:									
Vallers----------	Poor	Fair	Very poor	Very poor	Good	Good	Poor	Good	Very poor.
Hamerly----------	Fair	Fair	Poor	Fair	Fair	Fair	Fair	Fair	Fair.
21---------- Svea	Good	Good	Good	Good	Poor	Poor	Good	Poor	Good.
22*:									
Svea----------	Good	Good	Good	Good	Poor	Poor	Good	Poor	Good.
Barnes----------	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
23*:									
Hamerly----------	Good	Good	Good	Fair	Fair	Fair	Good	Fair	Fair.
Wyard----------	Good	Good	Good	Good	Fair	Fair	Good	Fair	Good.
24*:									
Hamerly----------	Good	Good	Good	Fair	Fair	Fair	Good	Fair	Fair.
Parnell----------	Very poor	Poor	Poor	Poor	Good	Good	Poor	Good	Poor.

See footnote at end of table.

TABLE 9.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements						Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Shrubs	Wetland plants	Shallow water areas	Openland wildlife	Wetland wildlife	Rangeland wildlife
25B*:									
Barnes	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Maddock	Poor	Fair	Good	Poor	Very poor	Very poor	Poor	Very poor	Good.
26B*:									
Barnes	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Svea	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
27B*:									
Barnes	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Buse	Fair	Good	Fair	Fair	Very poor	Very poor	Fair	Very poor	Fair.
27C*:									
Barnes	Fair	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Buse	Fair	Good	Fair	Fair	Very poor	Very poor	Fair	Very poor	Fair.
28F*:									
Barnes	Poor	Fair	Good	Fair	Very poor	Very poor	Fair	Very poor	Fair.
Buse	Very poor	Very poor	Fair	Fair	Very poor	Very poor	Poor	Very poor	Fair.
29D*:									
Buse	Poor	Fair	Fair	Fair	Very poor	Very poor	Fair	Very poor	Fair.
Svea	Poor	Poor	Fair	Fair	Very poor	Very poor	Poor	Very poor	Fair.
30C*:									
Barnes	Fair	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Maddock	Fair	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Swenoda	Fair	Good	Good	Fair	Very poor	Very poor	Good	Very poor	Fair.
31*:									
Fram	Good	Good	Good	Fair	Fair	Poor	Good	Poor	Fair.
Parnell	Very poor	Poor	Poor	Poor	Good	Good	Poor	Good	Poor.
33*:									
Fram	Good	Good	Good	Fair	Fair	Poor	Good	Poor	Fair.
Wyard	Good	Good	Good	Good	Fair	Fair	Good	Fair	Good.
36*:									
Heimdal	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Emrick	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
36B*:									
Heimdal	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Emrick	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.

See footnote at end of table.

TABLE 9.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements						Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Shrubs	Wetland plants	Shallow water areas	Openland wildlife	Wetland wildlife	Rangeland wildlife
37B*:									
Heimdal	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Esmond	Fair	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
37C*:									
Heimdal	Fair	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Esmond	Fair	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
38F*:									
Heimdal	Poor	Fair	Good	Fair	Poor	Very poor	Fair	Very poor	Fair.
Esmond	Very poor	Very poor	Good	Fair	Very poor	Very poor	Poor	Very poor	Fair.
39D*:									
Heimdal	Poor	Fair	Good	Fair	Poor	Very poor	Fair	Very poor	Fair.
Esmond	Poor	Fair	Good	Fair	Very poor	Very poor	Fair	Very poor	Fair.
41B---- Embden	Fair	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
42*:									
Wyndmere	Fair	Good	Good	Fair	Fair	Poor	Good	Poor	Fair.
Arveson	Poor	Fair	Fair	Fair	Good	Good	Fair	Good	Fair.
51---- Bearden	Good	Good	Good	Fair	Fair	Fair	Good	Fair	Fair.
52---- Glyndon	Good	Good	Good	Fair	Poor	Poor	Good	Poor	Fair.
60*:									
Cathay	Fair	Good	Good	Poor	Poor	Poor	Fair	Poor	Fair.
Heimdal	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
60B*:									
Heimdal	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Cathay	Fair	Good	Good	Poor	Poor	Very poor	Fair	Very poor	Fair.
61*:									
Larson	Poor	Poor	Poor	Very poor	Poor	Poor	Poor	Poor	Very poor.
Cathay	Fair	Good	Good	Poor	Poor	Poor	Fair	Poor	Fair.
62*:									
Miranda	Poor	Poor	Very poor	Very poor	Poor	Poor	Poor	Poor	Very poor.
Larson	Poor	Poor	Poor	Very poor	Poor	Poor	Poor	Poor	Very poor.
67---- Letcher	Poor	Poor	Poor	Very poor	Very poor	Very poor	Poor	Very poor	Very poor.

See footnote at end of table.

TABLE 9.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements						Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Shrubs	Wetland plants	Shallow water areas	Openland wildlife	Wetland wildlife	Rangeland wildlife
71---------- Spottswood	Good	Good	Fair	Fair	Poor	Very poor	Good	Very poor	Fair.
72---------- Divide	Fair	Fair	Good	Fair	Fair	Very poor	Fair	Poor	Fair.
77B---------- Arvilla	Fair	Good	Fair	Poor	Very poor	Very poor	Fair	Very poor	Poor.
78C*:									
Sioux----------	Very poor	Very poor	Poor	Poor	Very poor	Very poor	Very poor	Very poor	Poor.
Arvilla----------	Fair	Good	Fair	Poor	Very poor	Very poor	Fair	Very poor	Poor.
78F*:									
Coe----------	Very poor	Poor	Fair	Poor	Very poor	Very poor	Poor	Very poor	Fair.
Heimdal----------	Poor	Fair	Good	Fair	Poor	Very poor	Fair	Very poor	Fair.
80*:									
Towner----------	Fair	Good	Good	Fair	Poor	Poor	Good	Poor	Fair.
Barnes----------	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
81---------- Hecla	Fair	Good	Good	Fair	Poor	Poor	Good	Poor	Fair.
82B---------- Towner	Fair	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
84B---------- Lohnes	Fair	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
86B---------- Maddock	Fair	Good	Good	Fair	Poor	Very poor	Fair	Very poor	Fair.
89D*:									
Maddock----------	Poor	Fair	Good	Fair	Very poor	Very poor	Fair	Very poor	Fair.
Barnes----------	Fair	Good	Good	Fair	Very poor	Very poor	Good	Very poor	Fair.
Towner----------	Poor	Fair	Good	Fair	Poor	Very poor	Fair	Very poor	Fair.
90*:									
Ulen----------	Fair	Good	Good	Fair	Poor	Poor	Good	Poor	Fair.
Hecla----------	Fair	Good	Good	Fair	Poor	Poor	Good	Poor	Fair.
91B---------- Swenoda	Fair	Good	Good	Fair	Very poor	Very poor	Good	Very poor	Fair.
95*:									
Colvin----------	Poor	Fair	Fair	Fair	Good	Good	Poor	Good	Fair.
La Prairie--------	Good	Good	Good	Good	Poor	Poor	Good	Poor	Good.
96---------- La Prairie	Good	Good	Fair	---	Very poor	Very poor	Good	Very poor	Fair.

See footnote at end of table.

TABLE 9.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements						Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Shrubs	Wetland plants	Shallow water areas	Openland wildlife	Wetland wildlife	Rangeland wildlife
99*. Pits									
102---------- Kratka	Poor	Fair	Fair	Fair	Good	Good	Fair	Good	Fair.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 10.--BUILDING SITE DEVELOPMENT

(Some terms that describe restrictive soil features are defined in the "Glossary." See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
1---------- Southam	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: shrink-swell, low strength, ponding.
2---------- Parnell	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: shrink-swell, low strength, ponding.
3---------- Tonka	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: shrink-swell, low strength, ponding.
4---------- Manfred	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: shrink-swell, low strength, ponding.
7---------- Colvin	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: low strength, ponding, frost action.
8---------- Minnewaukan	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
9*:					
Lallie----------	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: shrink-swell, low strength, ponding.
Minnewaukan------	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
10*:					
Colvin----------	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, wetness.
Arveson----------	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness, frost action.
17*:					
Vallers----------	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness, frost action.

See footnote at end of table.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
17*:					
Hamerly	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: frost action.
21 Svea	Moderate: wetness.	Moderate: shrink-swell.	Moderate: shrink-swell, wetness.	Moderate: shrink-swell.	Severe: low strength.
22*:					
Svea	Moderate: wetness.	Moderate: shrink-swell.	Moderate: shrink-swell, wetness.	Moderate: shrink-swell.	Severe: low strength.
Barnes	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, low strength.
23*:					
Hamerly	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: frost action.
Wyard	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.
24*:					
Hamerly	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: frost action.
Parnell	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: shrink-swell, low strength, ponding.
25B*:					
Barnes	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: shrink-swell, low strength.
Maddock	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight.
26B*:					
Barnes	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: shrink-swell, low strength.
Svea	Moderate: wetness.	Moderate: shrink-swell.	Moderate: shrink-swell, wetness.	Moderate: shrink-swell, slope.	Severe: low strength.
27B*, 27C*:					
Barnes	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: shrink-swell, low strength.

See footnote at end of table.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
27B*, 27C*:					
Buse	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: shrink-swell, low strength.
28F*:					
Barnes	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Buse	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
29D*:					
Buse	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Moderate: shrink-swell, low strength, slope.
Svea	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength.
30C*:					
Barnes	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: shrink-swell, low strength.
Maddock	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight.
Swenoda	Moderate: wetness.	Slight	Moderate: wetness, shrink-swell.	Moderate: slope.	Moderate: frost action.
31*:					
Fram	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Severe: frost action.
Parnell	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: shrink-swell, low strength, ponding.
33*:					
Fram	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Severe: frost action.
Wyard	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.
36*:					
Heimdal	Slight	Slight	Slight	Slight	Moderate: frost action.
Emrick	Slight	Slight	Slight	Slight	Moderate: frost action.

See footnote at end of table.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
36B*:					
Heimdal	Slight	Slight	Slight	Moderate: slope.	Moderate: frost action.
Emrick	Slight	Slight	Slight	Moderate: slope.	Moderate: frost action.
37B*, 37C*:					
Heimdal	Slight	Slight	Slight	Moderate: slope.	Moderate: frost action.
Esmond	Slight	Slight	Slight	Moderate: slope.	Moderate: frost action.
38F*:					
Heimdal	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Esmond	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
39D*:					
Heimdal	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.
Esmond	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.
41B--Embden	Severe: cutbanks cave.	Slight	Moderate: wetness.	Slight	Moderate: frost action.
42*:					
Wyndmere	Severe: cutbanks cave, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Severe: frost action.
Arveson	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness, frost action.
51--Bearden	Severe: cutbanks cave, wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: low strength, frost action.
52--Glyndon	Moderate: wetness.	Slight	Moderate: wetness.	Slight	Severe: frost action.
60*:					
Cathay	Moderate: wetness.	Moderate: shrink-swell.	Moderate: wetness, shrink-swell.	Moderate: shrink-swell.	Severe: low strength.
Heimdal	Slight	Slight	Slight	Slight	Moderate: frost action.
60B*:					
Heimdal	Slight	Slight	Slight	Moderate: slope.	Moderate: frost action.

See footnote at end of table.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
60B*:					
Cathay	Moderate: wetness.	Moderate: shrink-swell.	Moderate: wetness, shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.
61*:					
Larson	Moderate: wetness.	Moderate: shrink-swell.	Moderate: wetness, shrink-swell.	Moderate: shrink-swell.	Severe: low strength.
Cathay	Moderate: wetness.	Moderate: shrink-swell.	Moderate: wetness, shrink-swell.	Moderate: shrink-swell.	Severe: low strength.
62*:					
Miranda	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell.	Moderate: shrink-swell, low strength, wetness.
Larson	Moderate: wetness.	Moderate: shrink-swell.	Moderate: wetness, shrink-swell.	Moderate: shrink-swell.	Severe: low strength.
67--Letcher	Moderate: wetness.	Slight	Moderate: wetness.	Slight	Moderate: frost action.
71--Spottswood	Severe: cutbanks cave.	Moderate: shrink-swell.	Moderate: wetness.	Moderate: shrink-swell.	Severe: low strength.
72--Divide	Severe: cutbanks cave.	Slight	Moderate: wetness.	Slight	Moderate: frost action.
77B--Arvilla	Severe: cutbanks cave.	Slight	Slight	Slight	Slight.
78C*:					
Sioux	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight.
Arvilla	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight.
78F*:					
Coe	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Heimdal	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
80*:					
Towner	Severe: cutbanks cave.	Slight	Moderate: wetness, shrink-swell.	Slight	Moderate: frost action.
Barnes	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, low strength.

See footnote at end of table.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
81---------- Hecla	Severe: cutbanks cave.	Slight----------	Moderate: wetness.	Slight----------	Slight.
82B---------- Towner	Severe: cutbanks cave.	Slight----------	Moderate: wetness, shrink-swell.	Slight----------	Moderate: frost action.
84B---------- Lohnes	Severe: cutbanks cave.	Slight----------	Slight----------	Slight----------	Slight.
86B---------- Maddock	Severe: cutbanks cave.	Slight----------	Slight----------	Slight----------	Slight.
89D*: Maddock----------	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.
Barnes----------	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Moderate: shrink-swell, low strength, slope.
Towner----------	Severe: cutbanks cave.	Slight----------	Moderate: wetness, shrink-swell.	Moderate: slope.	Moderate: frost action.
90*: Ulen----------	Severe: cutbanks cave.	Slight----------	Moderate: wetness.	Slight----------	Moderate: frost action.
Hecla----------	Severe: cutbanks cave.	Slight----------	Moderate: wetness.	Slight----------	Moderate: frost action.
91B---------- Swenoda	Moderate: wetness.	Slight----------	Moderate: wetness, shrink-swell.	Slight----------	Moderate: frost action.
95*: Colvin----------	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: low strength, wetness, flooding.
La Prairie-------	Moderate: wetness, flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.
96---------- La Prairie	Slight----------	Severe: flooding.	Severe: flooding.	Severe: flooding.	Moderate: shrink-swell, low strength, flooding.
99*. Pits					
102---------- Kratka	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 11.--SANITARY FACILITIES

(Some terms that describe restrictive soil features are defined in the "Glossary." See text for definitions of "slight," "good," and other terms. Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
1--- Southam	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
2--- Parnell	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
3--- Tonka	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
4---	Severe: percs slowly.	Severe:	Severe: excess sodium.	Severe:	Poor: ponding, excess sodium.
7--- Colvin	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Poor: ponding.
8--- Minnewaukan	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, wetness.
9*:					
Lallie	Severe: ponding, percs slowly.	Slight	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
Minnewaukan	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, wetness.
10*:					
Colvin	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
Arveson	Severe: wetness, percs slowly, poor filter.	Severe: seepage, wetness.	Severe: wetness.	Severe: seepage, wetness.	Poor: wetness, thin layer.
17*:					
Vallers	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.

See footnote at end of table.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
17*:					
Hamerly	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
21	Severe:	Moderate:	Severe:	Moderate:	Fair:
Svea	percs slowly.	seepage, wetness.	wetness.	wetness.	too clayey.
22*:					
Svea	Severe: percs slowly.	Moderate: seepage, wetness.	Severe: wetness.	Moderate: wetness.	Fair: too clayey.
Barnes	Severe: percs slowly.	Moderate: seepage.	Moderate: too clayey.	Slight	Fair: too clayey.
23*:					
Hamerly	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
Wyard	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
24*:					
Hamerly	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
Parnell	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
25B*:					
Barnes	Severe: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
Maddock	Severe: poor filter.	Severe: seepage.	Severe: too sandy.	Severe: seepage.	Poor: seepage, too sandy.
26B*:					
Barnes	Severe: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
Svea	Severe: percs slowly.	Moderate: slope, seepage, wetness.	Severe: wetness.	Moderate: wetness.	Fair: too clayey.
27B*:					
Barnes	Severe: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
Buse	Severe: percs slowly.	Moderate: slope.	Moderate: too clayey.	Slight	Fair: too clayey.

See footnote at end of table.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
27C*:					
Barnes	Severe: percs slowly.	Severe: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
Buse	Severe: percs slowly.	Severe: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
28F*:					
Barnes	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Buse	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
29D*:					
Buse	Severe: percs slowly.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.
Svea	Severe: percs slowly.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.
30C*:					
Barnes	Severe: percs slowly.	Severe: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
Maddock	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
Swenoda	Severe: wetness, percs slowly.	Severe: seepage, slope, wetness.	Moderate: wetness, too clayey.	Severe: seepage.	Fair: too clayey, wetness.
31*:					
Fram	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: wetness.
Parnell	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
33*:					
Fram	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: wetness.
Wyard	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
36*:					
Heimdal	Moderate: percs slowly.	Moderate: seepage.	Slight	Slight	Good.
Emrick	Moderate: percs slowly.	Moderate: seepage.	Slight	Slight	Good.

See footnote at end of table.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
36B*:					
Heimdal	Moderate: percs slowly.	Moderate: seepage, slope.	Slight	Slight	Good.
Emrick	Moderate: percs slowly.	Moderate: seepage, slope.	Slight	Slight	Good.
37B*:					
Heimdal	Moderate: percs slowly.	Moderate: seepage, slope.	Slight	Slight	Good.
Esmond	Moderate: percs slowly.	Moderate: seepage, slope.	Slight	Slight	Good.
37C*:					
Heimdal	Moderate: percs slowly.	Severe: slope.	Slight	Slight	Good.
Esmond	Moderate: percs slowly.	Severe: slope.	Slight	Slight	Good.
38F*:					
Heimdal	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Esmond	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
39D*:					
Heimdal	Moderate: percs slowly, slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
Esmond	Moderate: percs slowly, slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
41B---------- Embden	Moderate: wetness.	Severe: seepage.	Severe: seepage, wetness.	Severe: seepage.	Fair: too sandy.
42*:					
Wyndmere	Severe: wetness, percs slowly.	Severe: seepage, wetness.	Severe: wetness, too sandy.	Severe: seepage, wetness.	Poor: too sandy.
Arveson	Severe: wetness, percs slowly, poor filter.	Severe: seepage, wetness.	Severe: wetness.	Severe: seepage, wetness.	Poor: wetness, thin layer.
51---------- Bearden	Severe: wetness, percs slowly.	Severe: seepage, wetness.	Severe: seepage, wetness.	Severe: wetness.	Poor: hard to pack.

See footnote at end of table.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
52---------- Glyndon	Severe: wetness.	Severe: seepage, wetness.	Severe: wetness.	Severe: seepage, wetness.	Fair: too clayey, wetness.
60*:					
Cathay----------	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness, excess sodium.	Severe: wetness.	Poor: excess sodium.
Heimdal----------	Moderate: percs slowly.	Moderate: seepage, slope.	Slight----------	Slight----------	Good.
60B*:					
Heimdal----------	Moderate: percs slowly.	Moderate: seepage, slope.	Slight----------	Slight----------	Good.
Cathay----------	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness, excess sodium.	Severe: wetness.	Poor: excess sodium.
61*:					
Larson----------	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness, excess sodium.	Severe: wetness.	Poor: excess sodium.
Cathay----------	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness, excess sodium.	Severe: wetness.	Poor: excess sodium.
62*:					
Miranda----------	Severe: wetness, percs slowly.	Slight----------	Severe: wetness, excess sodium.	Severe: wetness.	Poor: excess sodium.
Larson----------	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness, excess sodium.	Severe: wetness.	Poor: excess sodium.
67---------- Letcher	Severe: wetness.	Severe: seepage.	Severe: seepage, excess sodium.	Severe: seepage.	Poor: excess sodium.
71---------- Spottswood	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, small stones.
72---------- Divide	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, small stones.
77B---------- Arvilla	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.

See footnote at end of table.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
78C*:					
Sioux	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
Arvilla	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
78F*:					
Coe	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, small stones.
Heimdal	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
80*:					
Towner	Severe: wetness, percs slowly, poor filter.	Severe: seepage, wetness.	Moderate: wetness, too clayey.	Severe: seepage.	Fair: too clayey, wetness.
Barnes	Severe: percs slowly.	Moderate: seepage.	Moderate: too clayey.	Slight	Fair: too clayey.
81 Hecla	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy.
82B Towner	Severe: wetness, percs slowly, poor filter.	Severe: seepage, wetness.	Moderate: wetness, too clayey.	Severe: seepage.	Fair: too clayey, wetness.
84B Lohnes	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
86B Maddock	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
89D*:					
Maddock	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
Barnes	Severe: percs slowly.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.
Towner	Severe: wetness, percs slowly, poor filter.	Severe: seepage, slope, wetness.	Moderate: wetness, too clayey.	Severe: seepage.	Fair: too clayey, wetness.

See footnote at end of table.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
90*:					
Ulen	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy.
Hecla	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: too sandy, seepage.
91B---------- Swenoda	Severe: wetness, percs slowly.	Severe: seepage, wetness.	Moderate: wetness, too clayey.	Severe: seepage.	Fair: too clayey, wetness.
95*:					
Colvin	Severe: flooding, wetness, percs slowly.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Poor: wetness.
La Prairie	Severe: flooding, wetness.	Severe: flooding.	Severe: flooding, wetness.	Severe: flooding.	Fair: too clayey.
96---------- La Prairie	Moderate: flooding, percs slowly.	Moderate: seepage.	Moderate: flooding, too clayey.	Moderate: flooding.	Fair: too clayey.
99*. Pits					
102---------- Kratka	Severe: wetness, percs slowly.	Severe: seepage, wetness.	Severe: wetness.	Severe: seepage, wetness.	Poor: wetness.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 12.--CONSTRUCTION MATERIALS

(Some terms that describe restrictive soil features are defined in the "Glossary." See text for definitions of "good," "fair," and other terms. Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
1--- Southam	Poor: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, wetness.
2--- Parnell	Poor: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
3--- Tonka	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, wetness.
4--- Manfred	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness, excess sodium, excess salt.
7--- Colvin	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
8--- Minnewaukan	Poor: wetness.	Probable	Improbable: too sandy.	Poor: too sandy, small stones, wetness.
9*:				
Lallie	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess salt, wetness.
Minnewaukan	Poor: wetness.	Probable	Improbable: too sandy.	Poor: too sandy, small stones, wetness.
10*:				
Colvin	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess salt, wetness.
Arveson	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess salt, wetness.
17*:				
Vallers	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess salt, wetness.

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
17*:				
Hamerly	Fair: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess salt.
21 Svea	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
22*:				
Svea	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Barnes	Fair: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, small stones.
23*:				
Hamerly	Fair: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Wyard	Fair: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: area reclaim, small stones.
24*:				
Hamerly	Fair: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Parnell	Poor: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
25B*:				
Barnes	Fair: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, small stones.
Maddock	Good	Improbable: thin layer.	Improbable: too sandy.	Poor: too sandy.
26B*:				
Barnes	Fair: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, small stones.
Svea	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
27B*, 27C*:				
Barnes	Fair: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, small stones.

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
27B*, 27C*:				
Buse	Fair: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, small stones.
28F*:				
Barnes	Fair: shrink-swell, low strength, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Buse	Poor: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
29D*:				
Buse	Fair: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, small stones, slope.
Svea	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
30C*:				
Barnes	Fair: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, small stones.
Maddock	Good	Probable	Improbable: too sandy.	Poor: too sandy.
Swenoda	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
31*:				
Fram	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Parnell	Poor: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
33*:				
Fram	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Wyard	Fair: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: area reclaim, small stones.
36*, 36B*:				
Heimdal	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Emrick	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
37B*, 37C*:				
Heimdal	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Esmond	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
38F*:				
Heimdal	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Esmond	Poor: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
39D*:				
Heimdal	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
Esmond	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
41B---- Embden	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
42*:				
Wyndmere	Fair: thin layer, wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: thin layer.
Arveson	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
51---- Bearden	Fair: wetness.	Probable	Improbable: too sandy.	Good.
52---- Glyndon	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
60*:				
Cathay	Fair: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess sodium.
Heimdal	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
60B*:				
Heimdal	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Cathay	Fair: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess sodium.
61*:				
Larson	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer, excess sodium.

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
61*:				
Cathay	Fair: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess sodium.
62*:				
Miranda	Fair: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess salt, excess sodium.
Larson	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer, excess sodium.
67 Letcher	Good	Improbable: excess fines.	Improbable: excess fines.	Poor: excess sodium.
71 Spottswood	Good	Probable	Probable	Poor: small stones, area reclaim.
72 Divide	Fair: wetness.	Probable	Probable	Poor: too sandy, small stones, area reclaim.
77B Arvilla	Good	Probable	Probable	Poor: too sandy, small stones, area reclaim.
78C*:				
Sioux	Good	Probable	Probable	Poor: too sandy, small stones, area reclaim.
Arvilla	Good	Probable	Probable	Poor: too sandy, small stones, area reclaim.
78F*:				
Coe	Fair: slope.	Probable	Probable	Poor: small stones, area reclaim, slope.
Heimdal	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
80*:				
Towner	Fair: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too sandy.
Barnes	Fair: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, small stones.

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
81 Hecla	Fair: thin layer.	Improbable: thin layer.	Improbable: too sandy.	Poor: too sandy.
82B Towner	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too sandy.
84B Lohnes	Good	Probable	Improbable: too sandy.	Poor: too sandy.
86B Maddock	Good	Probable	Improbable: too sandy.	Poor: too sandy.
89D*: Maddock	Good	Probable	Improbable: too sandy.	Poor: too sandy.
Barnes	Fair: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, small stones, slope.
Towner	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too sandy.
90*: Ulen	Fair: wetness.	Probable	Improbable: too sandy.	Poor: too sandy.
Hecla	Good	Probable	Improbable: too sandy.	Poor: thin layer.
91B Swenoda	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
95*: Colvin	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
La Prairie	Fair: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
96 La Prairie	Fair: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
99*. Pits				
102 Kratka	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 13.--WATER MANAGEMENT

(Some terms that describe restrictive soil features are defined in the "Glossary." See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not evaluated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Limitations for--		Features affecting--			
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
1---------- Southam	Slight	Severe: hard to pack, ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Erodes easily, ponding, percs slowly.	Wetness, excess salt, erodes easily.
2---------- Parnell	Slight	Severe: hard to pack, ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Ponding, percs slowly.	Wetness, percs slowly.
3---------- Tonka	Slight	Severe: ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Erodes easily, ponding, percs slowly.	Wetness, erodes easily, percs slowly.
4---------- Manfred	Slight	Severe: ponding, excess sodium.	Ponding, percs slowly, frost action.	Ponding, percs slowly, excess sodium.	Ponding, percs slowly.	Wetness, excess sodium, percs slowly.
7---------- Colvin	Moderate: seepage.	Severe: ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Ponding, percs slowly.	Wetness, percs slowly.
8---------- Minnewaukan	Severe: seepage.	Severe: seepage, piping, wetness.	Cutbanks cave	Wetness, droughty, fast intake.	Wetness, too sandy, soil blowing.	Wetness, droughty.
9*:						
Lallie----------	Slight	Severe: hard to pack, ponding.	Ponding, percs slowly.	Ponding, percs slowly.	Erodes easily, ponding, percs slowly.	Wetness, excess salt, erodes easily.
Minnewaukan------	Severe: seepage.	Severe: seepage, piping, wetness.	Cutbanks cave	Wetness, droughty, fast intake.	Wetness, too sandy, soil blowing.	Wetness, droughty.
10*:						
Colvin----------	Moderate: seepage.	Severe: wetness.	Percs slowly, frost action.	Wetness, percs slowly.	Wetness, percs slowly.	Wetness, excess salt, percs slowly.
Arveson----------	Severe: seepage.	Severe: piping, wetness.	Frost action, excess salt.	Wetness, excess salt.	Wetness--------	Wetness, excess salt.
17*:						
Vallers----------	Slight	Severe: piping, wetness.	Frost action, excess salt.	Wetness, excess salt.	Wetness--------	Wetness, excess salt.
Hamerly----------	Slight	Severe: piping.	Frost action, excess salt.	Wetness, excess salt.	Erodes easily, wetness.	Excess salt, erodes easily.
21---------- Svea	Moderate: seepage.	Severe: piping.	Deep to water	Favorable------	Erodes easily	Erodes easily.

See footnote at end of table.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for--		Features affecting--			
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
22*:						
Svea	Moderate: seepage.	Severe: piping.	Deep to water	Favorable	Erodes easily	Erodes easily.
Barnes	Slight	Severe: piping.	Deep to water	Favorable	Erodes easily	Erodes easily.
23*:						
Hamerly	Slight	Severe: piping.	Frost action	Wetness	Erodes easily, wetness.	Erodes easily.
Wyard	Moderate: seepage.	Severe: piping, wetness.	Frost action	Wetness	Erodes easily, wetness.	Wetness, erodes easily.
24*:						
Hamerly	Slight	Severe: piping.	Frost action	Wetness	Erodes easily, wetness.	Erodes easily.
Parnell	Slight	Severe: hard to pack, ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Ponding, percs slowly.	Wetness, percs slowly.
25B*:						
Barnes	Moderate: slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
Maddock	Severe: seepage.	Severe: seepage, piping.	Deep to water	Slope, droughty.	Too sandy, soil blowing.	Droughty.
26B*:						
Barnes	Moderate: slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
Svea	Moderate: slope, seepage.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
27B*, 27C*:						
Barnes	Moderate: slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
Buse	Moderate: slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
28F*:						
Barnes	Severe: slope.	Severe: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
Buse	Severe: slope.	Severe: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
29D*:						
Buse	Severe: slope.	Severe: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
Svea	Severe: slope.	Severe: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.

See footnote at end of table.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for--		Features affecting--			
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
30C*:						
Barnes	Moderate: slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
Maddock	Severe: seepage.	Severe: seepage, piping.	Deep to water	Slope, droughty, soil blowing.	Too sandy, soil blowing.	Droughty.
Swenoda	Severe: seepage.	Severe: piping.	Slope	Slope, wetness, soil blowing.	Erodes easily, wetness.	Erodes easily.
31*:						
Fram	Moderate: seepage.	Severe: piping.	Frost action	Wetness	Erodes easily, wetness.	Erodes easily.
Parnell	Slight	Severe: hard to pack, ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Ponding, percs slowly.	Wetness, percs slowly.
33*:						
Fram	Moderate: seepage.	Severe: piping.	Frost action	Wetness	Erodes easily, wetness.	Erodes easily.
Wyard	Moderate: seepage.	Severe: piping, wetness.	Frost action	Wetness	Erodes easily, wetness.	Wetness, erodes easily.
36*:						
Heimdal	Moderate: seepage.	Severe: piping.	Deep to water	Favorable	Erodes easily	Erodes easily.
Emrick	Moderate: seepage.	Severe: piping.	Deep to water	Favorable	Erodes easily	Erodes easily.
36B*:						
Heimdal	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
Emrick	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
37B*, 37C*:						
Heimdal	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
Esmond	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
38F*, 39D*:						
Heimdal	Severe: slope.	Severe: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
Esmond	Severe: slope.	Severe: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.

See footnote at end of table.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for--		Features affecting--			
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
41B---------- Embden	Severe: seepage.	Severe: seepage, piping.	Deep to water	Soil blowing, slope.	Soil blowing---	Favorable.
42*:						
Wyndmere---------	Severe: seepage.	Severe: piping.	Frost action, cutbanks cave.	Wetness, soil blowing.	Wetness, too sandy, soil blowing.	Favorable.
Arveson----------	Severe: seepage.	Severe: piping, wetness.	Frost action---	Wetness--------	Wetness--------	Wetness.
51---------- Bearden	Severe: seepage.	Moderate: thin layer, piping, hard to pack.	Percs slowly, frost action.	Wetness, percs slowly.	Erodes easily, wetness.	Erodes easily, percs slowly.
52---------- Glyndon	Severe: seepage.	Severe: piping.	Frost action---	Wetness--------	Wetness--------	Favorable.
60*:						
Cathay----------	Moderate: seepage.	Severe: piping, excess sodium.	Deep to water	Percs slowly---	Favorable------	Excess sodium, percs slowly.
Heimdal----------	Moderate: seepage.	Severe: piping.	Deep to water	Favorable------	Erodes easily	Erodes easily.
60B*:						
Heimdal----------	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope----------	Erodes easily	Erodes easily.
Cathay----------	Moderate: seepage, slope.	Severe: piping, excess sodium.	Deep to water	Slope, percs slowly.	Favorable------	Excess sodium, percs slowly.
61*:						
Larson----------	Moderate: seepage.	Severe: piping, excess sodium.	Deep to water	Percs slowly---	Favorable------	Excess sodium, percs slowly.
Cathay----------	Moderate: seepage.	Severe: piping, excess sodium.	Deep to water	Percs slowly---	Favorable------	Excess sodium, percs slowly.
62*:						
Miranda----------	Slight---------	Severe: piping, excess sodium.	Percs slowly, excess salt.	Wetness, percs slowly.	Wetness, percs slowly.	Excess sodium, percs slowly.
Larson----------	Moderate: seepage.	Severe: piping, excess sodium.	Deep to water	Percs slowly---	Favorable------	Excess sodium, percs slowly.
67---------- Letcher	Severe: seepage.	Severe: piping, excess sodium.	Deep to water	Percs slowly---	Soil blowing---	Excess sodium, percs slowly.

See footnote at end of table.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for--		Features affecting--			
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
71---------- Spottswood	Severe: seepage.	Severe: seepage.	Deep to water	Favorable------	Too sandy------	Favorable.
72---------- Divide	Severe: seepage.	Severe: seepage.	Cutbanks cave	Wetness--------	Wetness, too sandy.	Favorable.
77B---------- Arvilla	Severe: seepage.	Severe: seepage, piping.	Deep to water	Slope, droughty, soil blowing.	Too sandy, soil blowing.	Droughty.
78C*:						
Sioux----------	Severe: seepage.	Severe: seepage.	Deep to water	Slope, droughty.	Too sandy------	Droughty.
Arvilla----------	Severe: seepage.	Severe: seepage, piping.	Deep to water	Slope, droughty, soil blowing.	Too sandy, soil blowing.	Droughty.
78F*:						
Coe----------	Severe: seepage, slope.	Severe: seepage.	Deep to water	Slope, droughty.	Slope, droughty.	Large stones, slope, droughty.
Heimdal----------	Severe: slope.	Severe: piping.	Deep to water	Slope----------	Slope, erodes easily.	Slope, erodes easily.
80*:						
Towner----------	Severe: seepage.	Severe: piping.	Deep to water	Droughty, soil blowing.	Erodes easily, soil blowing.	Erodes easily, droughty.
Barnes----------	Slight---------	Severe: piping.	Deep to water	Soil blowing---	Erodes easily, soil blowing.	Erodes easily.
81---------- Hecla	Severe: seepage.	Severe: seepage, piping.	Deep to water	Droughty-------	Too sandy, soil blowing.	Droughty.
82B---------- Towner	Severe: seepage.	Severe: piping.	Deep to water	Slope, droughty, fast intake.	Erodes easily, soil blowing.	Erodes easily, droughty.
84B---------- Lohnes	Severe: seepage.	Severe: seepage, piping.	Deep to water	Slope, droughty, fast intake.	Too sandy, soil blowing.	Droughty.
86B---------- Maddock	Severe: seepage.	Severe: seepage, piping.	Deep to water	Slope, droughty, fast intake.	Too sandy, soil blowing.	Droughty.
89D*:						
Maddock----------	Severe: seepage, slope.	Severe: seepage, piping.	Deep to water	Slope, droughty, fast intake.	Slope, too sandy, soil blowing.	Slope, droughty.
Barnes----------	Severe: slope.	Severe: piping.	Deep to water	Slope----------	Slope, erodes easily.	Slope, erodes easily.
Towner----------	Severe: seepage.	Severe: piping.	Deep to water	Slope, droughty, fast intake.	Erodes easily, soil blowing.	Erodes easily, droughty.

See footnote at end of table.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for--		Features affecting--			
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
90*:						
Ulen	Severe: seepage.	Severe: seepage, piping.	Cutbanks cave	Wetness, droughty.	Wetness, too sandy, soil blowing.	Droughty.
Hecla	Severe: seepage.	Severe: seepage, piping.	Deep to water	Droughty, soil blowing.	Too sandy, soil blowing.	Droughty.
91B--- Swenoda	Severe: seepage.	Severe: piping.	Slope	Slope, wetness, soil blowing.	Erodes easily, wetness.	Erodes easily.
95*:						
Colvin	Moderate: seepage.	Severe: wetness.	Percs slowly, flooding, frost action.	Wetness, percs slowly.	Wetness, percs slowly.	Wetness, percs slowly.
La Prairie	Moderate: seepage.	Severe: piping.	Deep to water	Flooding	Favorable	Favorable.
96--- La Prairie	Moderate: seepage.	Severe: piping.	Deep to water	Favorable	Favorable	Favorable.
99*. Pits						
102--- Kratka	Severe: seepage.	Severe: piping, wetness.	Favorable	Wetness, droughty.	Wetness, soil blowing.	Wetness, droughty, rooting depth.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 14.--ENGINEERING INDEX PROPERTIES

(The symbol < means less than; > means more than. Absence of an entry indicates that data were not estimated)

Soil name and map symbol	Depth	USDA texture	Classification		Fragments	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	3-10 inches	4	10	40	200		
	In				Pct					Pct	
1----------	0-10	Silt loam--------	CL, CL-ML	A-4, A-6	0	100	95-100	90-100	85-100	25-40	5-15
Southam	10-32	Silty clay, clay, silty clay loam.	CL, CH	A-7	0	100	95-100	90-100	85-100	40-75	15-50
	32-60	Silty clay, silty clay loam, loam.	CL, CH, CL-ML	A-6, A-7, A-4	0	100	95-100	85-100	60-100	20-75	5-50
2----------	0-9	Silty clay loam	CL, CH	A-7	0	100	100	95-100	85-100	40-60	15-30
Parnell	9-44	Clay loam, silty clay loam, silty clay.	CL, CH	A-7	0	100	95-100	90-100	70-100	40-80	20-50
	44-60	Clay loam, silty clay loam, silty clay.	CL, CH	A-6, A-7	0	95-100	90-100	80-95	70-95	30-80	15-50
3----------	0-15	Silt loam--------	CL, CL-ML	A-4, A-6	0-2	100	95-100	90-100	70-90	20-35	5-15
Tonka	15-29	Silty clay loam, silty clay, clay	CH, CL	A-6, A-7	0-2	100	95-100	90-100	75-95	35-55	15-35
	29-60	Silty clay loam, clay loam, loam.	CL, CL-ML	A-6, A-7, A-4	0-3	90-100	85-100	60-100	50-90	25-50	5-30
4----------	0-7	Loam----------	CL, CL-ML	A-4, A-6	0	100	100	85-95	60-75	20-40	5-15
Manfred	7-60	Loam, clay loam, silt loam.	CL, CH	A-6, A-7	0	95-100	90-100	85-100	50-95	25-55	10-35
7----------	0-7	Silt loam--------	CL	A-6	0	100	100	90-100	80-95	25-40	10-20
Colvin	7-36	Silt loam, silty clay loam.	CL	A-6, A-7	0	100	100	90-100	80-95	25-50	10-30
	36-60	Loam, silt loam, silty clay loam.	CL	A-6, A-7	0	100	100	90-100	70-95	25-50	10-25
8----------	0-1	Loamy fine sand	SM	A-2	0	90-100	70-100	50-85	15-30	---	NP
Minnewaukan	1-60	Loamy fine sand, fine sand, fine sandy loam.	SM, SP-SM	A-2, A-3	0	90-100	70-100	50-100	5-35	---	NP
9*:											
Lallie----------	0-5	Loam----------	CL, CL-ML	A-4, A-6	0	100	100	85-100	60-90	25-40	5-20
	5-60	Silty clay loam, silty clay, clay.	CL, CH	A-7	0	100	95-100	90-100	85-100	45-95	20-60
Minnewaukan-----	0-1	Loamy fine sand	SM	A-2	0	90-100	70-100	50-85	15-30	---	NP
	1-60	Loamy fine sand, fine sand, fine sandy loam.	SM, SP-SM	A-2, A-3	0	90-100	70-100	50-100	5-35	---	NP
10*:											
Colvin----------	0-7	Silt loam--------	CL	A-6	0	100	100	90-100	80-95	20-35	10-20
	7-60	Silt loam, silty clay loam.	CL	A-6, A-7	0	100	100	90-100	80-95	20-50	10-30

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag-ments	Percentage passing sieve number--				Liquid limit	Plas-ticity index
			Unified	AASHTO	3-10 inches	4	10	40	200		
	In				Pct					Pct	
10*:											
Arveson	0-11	Loam	ML	A-4	0-1	100	95-100	85-90	50-80	25-40	NP-10
	11-26	Sandy clay loam, sandy loam, loam.	SM, SC-SM	A-4	0	100	95-100	60-85	35-50	<20	NP-5
	26-41	Fine sand, loamy fine sand, sandy loam.	SP-SM, SM, SC-SM	A-3, A-2, A-4	0	100	95-100	50-80	5-45	<20	NP-5
	41-60	Clay loam	CL	A-7	0	100	90-100	75-95	50-75	40-50	15-25
17*:											
Vallers	0-12	Loam	ML	A-4	0-5	95-100	90-100	80-90	65-80	25-40	3-10
	12-24	Clay loam, silty clay loam, loam.	CL	A-6	0-5	95-100	90-100	80-95	50-80	30-40	10-20
	24-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	85-95	60-75	20-40	5-20
Hamerly	0-9	Loam	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	80-95	60-90	25-40	5-20
	9-30	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	80-95	60-75	25-45	5-20
	30-60	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	80-95	60-75	25-45	5-20
21	0-20	Loam	CL, CL-ML	A-4, A-6	0-5	95-100	85-100	80-95	60-90	20-40	5-25
Svea	20-25	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-100	60-90	20-45	5-25
	25-60	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-100	60-85	20-50	5-30
22*:											
Svea	0-20	Loam	CL, CL-ML	A-4, A-6	0-5	95-100	85-100	80-95	60-90	20-40	5-25
	20-25	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-100	60-90	20-45	5-25
	25-60	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-100	60-85	20-50	5-30
Barnes	0-9	Loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	80-100	60-90	20-40	5-20
	9-20	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
	20-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
23*:											
Hamerly	0-9	Loam	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	80-95	60-90	20-40	5-20
	9-30	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	80-95	60-75	20-45	5-25
	30-60	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	75-95	55-75	20-45	5-25
Wyard	0-24	Loam	CL-ML, CL	A-4, A-6, A-7	0	95-100	90-100	85-100	60-90	25-45	5-25
	24-60	Loam, sandy loam, clay loam.	ML, CL, SC, CL-ML	A-4, A-6, A-7	0-10	95-100	90-100	80-100	35-85	20-45	3-25
24*:											
Hamerly	0-9	Loam	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	80-95	60-90	20-40	5-20
	9-30	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	80-95	60-75	20-45	5-25
	30-60	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	75-95	55-75	20-45	5-25

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	3-10 inches	4	10	40	200		
	In				Pct					Pct	
24*:											
Parnell	0-9	Silty clay loam	CL, CH	A-7	0	100	100	95-100	85-100	40-60	15-30
	9-44	Clay loam, silty clay loam, silty clay.	CL, CH	A-7	0	100	95-100	90-100	70-100	40-80	20-50
	44-60	Clay loam, silty clay loam, silty clay.	CL, CH	A-6, A-7	0	95-100	90-100	80-95	70-95	30-80	15-50
25B*:											
Barnes	0-9	Loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	80-100	60-90	20-40	5-20
	9-20	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
	20-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
Maddock	0-8	Sandy loam	SM, SC-SM	A-2, A-4	0	100	100	60-85	30-50	<25	NP-5
	8-41	Loamy sand, loamy fine sand, fine sand.	SM, SP-SM, SC-SM	A-2, A-3	0	100	95-100	60-95	5-35	<25	NP-5
	41-60	Fine sandy loam, loam, clay loam.	SC, CL, SC-SM, CL-ML	A-4, A-6	0	100	95-100	70-100	40-80	25-45	5-20
26B*:											
Barnes	0-9	Loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	80-100	60-90	20-40	5-20
	9-20	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
	20-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
Svea	0-20	Loam	CL, CL-ML	A-4, A-6	0-5	95-100	85-100	80-95	60-90	20-40	5-25
	20-25	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-100	60-90	20-45	5-25
	25-60	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-100	60-85	20-50	5-30
27B*, 27C*, 28F*:											
Barnes	0-9	Loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	80-100	60-90	20-40	5-20
	9-20	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
	20-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
Buse	0-7	Loam	ML, CL, CL-ML	A-4, A-6	0	90-100	85-95	70-95	55-90	20-35	3-15
	7-60	Loam, clay loam	CL, CL-ML, ML	A-4, A-6, A-7	0	90-100	85-100	70-90	55-85	25-45	5-20
29D*:											
Buse	0-7	Loam	ML, CL, CL-ML	A-4, A-6	0	90-100	85-95	70-95	55-90	20-35	3-15
	7-60	Loam, clay loam	CL, CL-ML, ML	A-4, A-6, A-7	0	90-100	85-100	70-90	55-85	25-45	5-20
Svea	0-20	Loam	CL, CL-ML	A-4, A-6	0-5	95-100	85-100	80-95	60-90	20-40	5-25
	20-25	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-100	60-90	20-45	5-25
	25-60	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-100	60-90	20-50	5-30
30C*:											
Barnes	0-9	Loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	80-100	60-90	20-40	5-20
	9-20	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
	20-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag-ments	Percentage passing sieve number--				Liquid limit	Plas-ticity index
			Unified	AASHTO	3-10 inches	4	10	40	200		
	In				Pct					Pct	
30C*:											
Maddock	0-12	Sandy fine loam	SM	A-2, A-4	0	100	100	60-85	30-50	---	NP
	12-60	Loamy fine sand, fine sand, sand.	SM, SP-SM	A-2, A-3	0	95-100	95-100	60-100	5-35	---	NP
Swenoda	0-11	Fine sandy loam	SM	A-2, A-4	0	100	95-100	70-100	30-50	20-30	NP-7
	11-37	Fine sandy loam, sandy loam, loamy fine sand.	SC-SM, SM, ML, CL-ML	A-2, A-4	0	100	95-100	60-100	30-55	15-30	NP-10
	37-60	Silt loam, silty clay loam, loam.	CL, CL-ML	A-4, A-6, A-7	0-5	90-100	90-100	75-100	50-95	20-50	5-30
31*:											
Fram	0-8	Loam	ML	A-4	0-1	95-100	95-100	85-100	60-90	20-40	NP-10
	8-60	Sandy loam, fine sandy loam, loam.	SM, ML	A-4	0-1	95-100	95-100	60-100	35-90	20-40	NP-10
Parnell	0-9	Silty clay loam	CL, CH	A-7	0	100	100	95-100	85-100	40-60	15-30
	9-44	Clay loam, silty clay loam, silty clay.	CL, CH	A-7	0	100	95-100	90-100	70-100	40-80	20-50
	44-60	Clay loam, silty clay loam, silty clay.	CL, CH	A-6, A-7	0	95-100	90-100	80-95	70-95	30-80	15-50
33*:											
Fram	0-8	Loam	ML	A-4	0-1	95-100	95-100	85-100	60-90	20-40	NP-10
	8-60	Sandy loam, fine sandy loam, loam.	SM, ML	A-4	0-1	95-100	95-100	60-100	35-90	20-40	NP-10
Wyard	0-24	Loam	CL-ML, CL	A-4, A-6, A-7	0	95-100	90-100	85-100	60-90	25-45	5-25
	24-60	Loam, sandy loam, clay loam.	ML, CL, SC, CL-ML	A-4, A-6, A-7	0-10	95-100	90-100	80-100	35-85	20-45	3-25
36*, 36B*:											
Heimdal	0-7	Loam	ML	A-4	0-1	95-100	95-100	85-100	60-90	20-40	NP-10
	7-14	Loam	ML	A-4	0-1	95-100	95-100	85-95	60-75	20-40	NP-10
	14-60	Loam, sandy loam	ML, SM, CL, CL-ML	A-4, A-6	0-5	95-100	90-100	60-100	35-90	20-40	NP-15
Emrick	0-16	Loam	ML	A-4	0-1	95-100	95-100	85-100	60-90	<40	NP-10
	16-22	Loam	ML	A-4	0-1	95-100	95-100	85-95	55-75	<40	NP-10
	22-60	Loam, sandy loam	ML, SM, SC	A-4, A-6	0-5	90-100	90-100	60-100	35-90	<40	NP-15
37B*, 37C*, 38F*, 39D*:											
Heimdal	0-7	Loam	ML	A-4	0-1	95-100	95-100	85-100	60-90	20-40	NP-10
	7-14	Loam	ML	A-4	0-1	95-100	95-100	85-95	60-75	20-40	NP-10
	14-60	Loam, sandy loam	ML, SM, CL, CL-ML	A-4, A-6	0-5	95-100	90-100	60-100	35-90	20-40	NP-15
Esmond	0-7	Loam	ML	A-4	0-1	95-100	95-100	85-100	60-90	20-40	NP-10
	7-60	Loam, sandy loam, fine sandy loam.	ML, SM, SC, CL	A-4, A-6	0-5	90-100	85-100	60-100	35-90	20-40	NP-15

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	3-10 inches	4	10	40	200		
	In				Pct					Pct	
41B----------	0-17	Fine sandy loam	SM, ML	A-2, A-4	0	100	100	60-95	30-75	<35	NP-10
Embden	17-40	Fine sandy loam, sandy loam.	SM, ML	A-2, A-4	0	100	100	60-100	25-55	---	NP
	40-60	Fine sandy loam, sandy loam, fine sand.	SM	A-2, A-4	0	100	100	50-100	15-50	---	NP
42*:											
Wyndmere--------	0-11	Fine sandy loam	SM, ML, SC, SC-SM	A-2, A-4	0	100	100	60-80	30-55	10-30	NP-10
	11-29	Sandy loam, fine sandy loam.	SM, ML, SC, SC-SM	A-2, A-4	0	100	100	60-90	30-55	10-30	NP-10
	29-55	Fine sand, loamy fine sand, fine sandy loam.	SM, ML	A-2, A-4	0	100	100	60-100	20-55	---	NP
	55-60	Loam, clay loam, silt loam.	CL, CL-ML	A-4, A-6, A-7	0-5	90-100	85-100	75-100	55-90	20-45	5-30
Arveson---------	0-11	Loam----------	ML	A-4	0-1	100	95-100	85-90	50-80	25-40	NP-10
	11-26	Sandy clay loam, sandy loam, loam.	SM, SC-SM	A-4	0	100	95-100	60-85	35-50	<20	NP-5
	26-41	Fine sand, loamy fine sand, fine sandy loam.	SP-SM, SM, SC-SM	A-3, A-2, A-4	0	100	95-100	50-85	5-50	<20	NP-5
	41-60	Clay loam--------	CL	A-7	0	100	90-100	75-95	50-75	40-50	15-25
51----------	0-8	Silty clay loam	CL, CH	A-6, A-7	0	100	100	95-100	80-95	25-55	10-30
Bearden	8-35	Silt loam, silty clay loam.	CL, CH	A-6, A-7	0	100	100	90-100	80-95	25-55	10-30
	35-51	Silt loam, silty clay loam, loam.	CL, CH	A-6, A-7	0	100	100	90-100	80-95	25-55	10-30
	51-60	Sand, fine sand	SP-SM, SM	A-2, A-3	0	100	100	50-80	5-35	<20	NP
52----------	0-13	Loam----------	ML	A-4	0	100	100	95-100	70-95	20-40	NP-10
Glyndon	13-33	Silt loam, very fine sandy loam, loam.	ML, CL-ML, CL	A-4	0	100	100	90-100	60-95	20-30	NP-10
	33-43	Very fine sandy loam, silt loam.	ML, CL, CL-ML	A-4	0	100	100	90-100	60-95	20-30	NP-10
	43-60	Silt loam, silty clay loam.	CL-ML, CL	A-4, A-6	0	100	100	95-100	80-100	20-40	5-20
60*:											
Cathay----------	0-8	Loam----------	ML, CL, CL-ML	A-4	0-5	95-100	90-100	75-95	50-95	25-35	5-10
	8-18	Clay loam, loam	CL	A-6	0-5	95-100	90-100	85-95	60-85	25-40	10-25
	18-60	Loam----------	ML, CL, CL-ML	A-4, A-6	0-5	95-100	90-100	85-95	60-75	25-40	3-25
Heimdal---------	0-7	Loam----------	ML	A-4	0-1	95-100	95-100	85-100	60-90	20-40	NP-10
	7-14	Loam----------	ML	A-4	0-1	95-100	95-100	85-95	60-75	20-40	NP-10
	14-60	Loam, sandy loam	ML, SM, CL, CL-ML	A-4, A-6	0-5	95-100	90-100	60-100	35-90	20-40	NP-15
60B*:											
Heimdal---------	0-7	Loam----------	ML	A-4	0-1	95-100	95-100	85-100	60-90	20-40	NP-10
	7-14	Loam----------	ML	A-4	0-1	95-100	95-100	85-95	60-75	20-40	NP-10
	14-60	Loam, sandy loam	ML, SM, CL, CL-ML	A-4, A-6	0-5	95-100	90-100	60-100	35-90	20-40	NP-15

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	3-10 inches	4	10	40	200		
	In				Pct					Pct	
60B*:											
Cathay	0-8	Loam	ML, CL, CL-ML	A-4	0-5	95-100	90-100	75-95	50-95	25-35	5-10
	8-18	Clay loam, loam	CL	A-6	0-5	95-100	90-100	85-95	60-85	25-40	10-25
	18-60	Loam	ML, CL, CL-ML	A-4, A-6	0-5	95-100	90-100	85-95	60-75	25-40	3-18
61*:											
Larson	0-11	Loam	CL, CL-ML	A-4, A-6	0-5	95-100	85-100	75-100	50-90	15-40	5-20
	11-23	Loam, clay loam, silty clay loam.	CL	A-6, A-7	0-5	95-100	85-100	75-100	60-80	25-45	5-30
	23-60	Loam, clay loam, silt loam.	CL, CL-ML	A-6, A-4, A-7	0-5	95-100	85-100	75-100	50-90	15-45	5-25
Cathay	0-8	Loam	ML, CL, CL-ML	A-4	0-5	95-100	90-100	75-95	50-95	25-35	5-10
	8-18	Clay loam, loam	CL	A-6	0-5	95-100	90-100	85-95	65-85	25-40	10-25
	18-60	Loam	ML, CL, CL-ML	A-4, A-6	0-5	95-100	90-100	85-95	60-75	25-40	3-18
62*:											
Miranda	0-4	Loam, silt loam	CL-ML, CL, ML	A-4, A-6	0	100	100	85-95	60-85	20-40	3-15
	4-15	Loam, clay loam	CL	A-6, A-7	0-5	95-100	95-100	85-95	50-80	30-50	10-30
	15-60	Loam, clay loam, sandy loam.	CL, ML, SM	A-6, A-7, A-4	0-5	95-100	95-100	60-95	30-80	20-50	NP-30
Larson	0-11	Loam	CL, CL-ML	A-4, A-6	0-5	95-100	85-100	75-100	50-90	15-40	5-20
	11-23	Loam, clay loam, silty clay loam.	CL	A-6, A-7	0-5	95-100	85-100	75-100	60-80	30-45	10-30
	23-60	Loam, clay loam, silt loam.	CL, CL-ML	A-6, A-4, A-7	0-5	95-100	85-100	75-100	50-90	15-45	5-25
67	0-15	Fine sandy loam	SM, SC-SM	A-4	0	100	100	60-95	35-50	15-30	NP-7
Letcher	15-22	Sandy loam, fine sandy loam, loamy fine sand.	SM, SC-SM	A-2, A-4	0	100	100	60-95	20-45	15-30	NP-7
	22-36	Loam, sandy loam, fine sandy loam.	SM, SC, ML, CL	A-4, A-6, A-2	0	100	100	60-95	30-60	25-40	3-18
	36-60	Sandy loam, fine sandy loam, loamy fine sand.	SM, SC, ML, CL	A-2, A-4, A-6	0	100	95-100	50-95	30-60	25-40	3-18
71	0-8	Loam	CL-ML, CL	A-6, A-4	0	95-100	95-100	90-100	65-90	25-40	5-15
Spottswood	8-25	Clay loam, loam, gravelly loam.	CL	A-6, A-7	0	95-100	70-100	65-100	50-80	30-45	10-20
	25-60	Gravelly sand, fine sand, gravelly loamy sand.	SM, GM, SP-SM, SC	A-2, A-1	0-5	40-80	25-75	15-70	10-30	<30	NP-15
72	0-10	Loam	CL, CL-ML	A-4, A-6	0	95-100	95-100	85-95	60-85	25-40	5-20
Divide	10-26	Loam, clay loam, gravelly loam.	CL, CL-ML, SC-SM, SC	A-4, A-6, A-7	0-3	95-100	75-100	55-90	35-80	20-45	5-20
	26-60	Stratified sand to gravelly sand.	GM, SM, GP-GM, SP-SM	A-1, A-3	0-5	25-100	15-100	10-70	5-25	<30	NP-5

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	3-10 inches	4	10	40	200		
	In				Pct					Pct	
77B---------- Arvilla	0-11	Sandy loam-------	SM, SC, SC-SM	A-2, A-4, A-6	0	95-100	90-100	50-80	20-45	<30	NP-15
	11-18	Sandy loam, loam, coarse sandy loam.	SM, SC, SC-SM	A-2, A-4, A-6	0	95-100	90-100	50-80	20-45	<30	NP-15
	18-60	Gravelly coarse sand, coarse sand, sand.	SP-SM, GP, SM, GP-GM	A-1, A-2, A-3	0	35-100	25-100	10-60	0-15	---	NP
78C*:											
Sioux----------	0-7	Loam-------------	ML, CL	A-4, A-6	0-5	95-100	85-100	70-90	55-75	30-40	5-15
	7-13	Gravelly loam, gravelly sandy loam, gravelly loamy sand.	SM, GM	A-4, A-2, A-1	0-5	60-90	50-80	45-70	15-50	20-35	NP-7
	13-60	Extremely gravelly sand, very gravelly loamy sand, very gravelly sand.	GM, GP, SM, SP	A-1	0	25-75	20-60	5-35	0-25	<25	NP-5
Arvilla---------	0-11	Sandy loam-------	SM, SC, SC-SM	A-2, A-4, A-6	0	95-100	90-100	50-80	20-45	<30	NP-15
	11-18	Sandy loam, loam, coarse sandy loam.	SM, SC, SC-SM	A-2, A-4, A-6	0	95-100	90-100	50-80	20-45	<30	NP-15
	18-60	Gravelly coarse sand, coarse sand, sand.	SP-SM, GP, SP, GP-GM	A-1, A-2, A-3	0	35-100	25-100	10-60	0-10	---	NP
78F*:											
Coe----------	0-5	Loam-------------	ML, CL-ML	A-4	0-5	95-100	95-100	60-80	50-75	<25	NP-5
	5-60	Gravelly coarse sand, gravelly loam, very gravelly sand.	SM, GP-GM, SP-SM, GM	A-1, A-2	5-25	50-95	30-75	15-60	10-30	<55	NP-15
Heimdal---------	0-7	Loam-------------	ML	A-4	0-1	95-100	95-100	85-100	60-90	20-40	NP-10
	7-14	Loam-------------	ML	A-4	0-1	95-100	95-100	85-95	60-75	20-40	NP-10
	14-60	Loam, sandy loam	ML, SM, CL, CL-ML	A-4, A-6	0-5	95-100	90-100	60-100	35-90	20-40	NP-15
80*:											
Towner----------	0-14	Sandy loam-------	SM, SC-SM	A-2, A-4	0	100	100	60-85	30-45	<25	NP-5
	14-34	Loamy sand, loamy fine sand, fine sand.	SM, SW-SM, SC-SM, SP-SM	A-2, A-3	0	100	95-100	50-100	5-35	<20	NP-5
	34-60	Loam, silt loam, silty clay loam.	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	85-100	55-100	25-40	5-15
Barnes----------	0-9	Sandy loam-------	SM, SC, SC-SM	A-4, A-2, A-6	0-5	90-100	85-100	60-95	30-65	20-40	NP-15
	9-20	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
	20-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	3-10 inches	4	10	40	200		
	In				Pct					Pct	
81----------	0-12	Fine sandy loam	SM, SC-SM	A-2, A-4	0	100	95-100	60-85	30-50	<25	NP-7
Hecla	12-38	Loamy sand, loamy fine sand, fine sand.	SM, SC-SM, SP-SM	A-2	0	100	95-100	85-100	12-35	<25	NP-7
	38-51	Loamy sand, fine sand, loamy fine sand.	SM, SC-SM, SP-SM	A-2	0	100	95-100	85-100	10-35	<25	NP-7
	51-60	Loam, clay loam, silt loam.	CL	A-6, A-7	0-5	95-100	90-100	85-95	50-80	30-50	10-25
82B----------	0-14	Loamy fine sand	SM, SC-SM	A-2	0	100	100	50-80	15-35	<25	NP-5
Towner	14-34	Loamy sand, loamy fine sand, fine sand.	SM, SC-SM, SW-SM, SP-SM	A-2, A-3	0	100	95-100	50-100	5-35	<25	NP-5
	34-60	Loam, silt loam, silty clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	85-100	55-100	25-50	5-30
84B----------	0-11	Loamy coarse sand	SM, SP-SM	A-2, A-1	0	100	100	45-65	10-25	---	NP
Lohnes	11-20	Coarse sand, loamy coarse sand, loamy sand.	SM, SP-SM, SP	A-2, A-1, A-3	0	95-100	95-100	35-60	2-20	---	NP
	20-60	Coarse sand, loamy coarse sand, loamy sand.	SM, SP-SM, SP	A-2, A-1, A-3	0	95-100	95-100	35-60	2-20	---	NP
86B----------	0-12	Loamy fine sand	SM	A-2	0	100	100	50-80	15-35	---	NP
Maddock	12-60	Loamy sand, loamy fine sand, fine sand.	SM, SP-SM	A-2, A-3	0	95-100	95-100	60-100	5-35	---	NP
89D*:											
Maddock---------	0-12	Loamy fine sand	SM	A-2	0	100	100	50-80	15-35	---	NP
	12-60	Loamy sand, loamy fine sand, fine sand.	SM, SP-SM	A-2, A-3	0	95-100	95-100	60-100	5-35	---	NP
Barnes----------	0-9	Loam----------	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	80-100	60-90	20-40	5-20
	9-20	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
	20-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
Towner----------	0-14	Loamy fine sand	SM, SC-SM	A-2	0	100	100	50-80	15-35	<25	NP-5
	14-34	Loamy sand, loamy fine sand, fine sand.	SM, SC-SM, SW-SM, SP-SM	A-2, A-3	0	100	95-100	50-100	5-35	<25	NP-5
	34-60	Loam, silt loam, silty clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	85-100	55-100	25-50	5-30
90*:											
Ulen----------	0-9	Fine sandy loam	SM, SC-SM, SC	A-4	0	100	100	80-100	35-50	<25	NP-8
	9-42	Loamy fine sand, fine sand.	SM	A-2	0	100	95-100	70-95	12-35	---	NP
	42-60	Fine sand, loamy fine sand, sand.	SP-SM, SM	A-3, A-2	0	100	95-100	80-100	5-35	---	NP

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	3-10 inches	4	10	40	200		
	In				Pct					Pct	
90*:											
Hecla	0-12	Fine sandy loam	SM, SC-SM	A-2, A-4	0	100	95-100	60-85	30-50	<25	NP-7
	12-38	Loamy sand, loamy fine sand, fine sand.	SM, SC-SM, SP-SM	A-2	0	100	95-100	85-100	10-35	<25	NP-7
	38-60	Loamy sand, fine sand, loamy fine sand.	SM, SC-SM, SP-SM	A-2	0	100	95-100	85-100	10-35	<25	NP-7
91B	0-11	Fine sandy loam	SM	A-2, A-4	0	100	95-100	70-100	30-50	20-30	NP-7
Swenoda	11-37	Fine sandy loam, sandy loam, loamy fine sand.	SC-SM, SM, ML, CL-ML	A-2, A-4	0	100	95-100	60-100	30-55	15-30	NP-10
	37-60	Silt loam, silty clay loam, loam.	CL, CL-ML	A-4, A-6, A-7	0-5	90-100	90-100	75-100	50-95	20-50	5-30
95*:											
Colvin	0-7	Silt loam	CL	A-6	0	100	100	90-100	80-95	25-40	10-20
	7-36	Silt loam, silty clay loam.	CL	A-6, A-7	0	100	100	90-100	80-95	25-50	10-30
	36-60	Loam, silt loam, silty clay loam.	CL	A-6, A-7	0	100	100	90-100	70-95	25-50	10-25
La Prairie	0-8	Loam	CL-ML, CL	A-4, A-6	0	100	100	85-95	70-80	25-40	5-15
	8-24	Silt loam, loam, silty clay loam.	CL-ML, CL	A-4, A-6, A-7	0	100	100	85-100	50-80	25-45	5-25
	24-50	Silt loam, loam, silty clay loam.	CL-ML, CL	A-4, A-6, A-7	0	100	100	85-100	70-80	25-45	5-25
	50-60	Stratified loam to silty clay loam.	CL-ML, CL, SC, SC-SM	A-4, A-6, A-7	0	100	95-100	75-100	45-80	25-45	5-25
96	0-8	Loam	CL-ML, CL	A-4, A-6	0	100	100	85-95	70-80	25-40	5-15
La Prairie	8-24	Silt loam, loam, silty clay loam.	CL-ML, CL	A-4, A-6, A-7	0	100	100	85-100	50-80	25-45	5-25
	24-50	Silt loam, loam, silty clay loam.	CL-ML, CL	A-4, A-6, A-7	0	100	100	85-100	70-80	25-45	5-25
	50-60	Stratified loam to silty clay loam.	CL-ML, CL, SC, SC-SM	A-4, A-6, A-7	0	100	95-100	75-100	45-80	25-45	5-25
99*.											
Pits											
102	0-8	Fine sandy loam	SM, SC-SM	A-4	0	95-100	90-100	50-80	36-50	<25	NP-6
Kratka	8-32	Loamy sand, fine sand, loamy fine sand.	SP-SM, SM	A-3, A-2	0	95-100	90-100	50-80	5-10	---	NP
	32-60	Loam, silty clay loam, silt loam.	SC-SM, SC, CL-ML, CL	A-4, A-6	0	95-100	90-100	70-90	40-75	15-40	5-25

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS

(The symbol < means less than; > means more than. Entries under "Erosion factors--T" apply to the entire profile. Entries under "Wind erodibility group" apply only to the surface layer. Absence of an entry indicates that data were not available or were not estimated)

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors		Wind erodibility group
							K	T	
	In	In/hr	In/in	pH	mmhos/cm				
1----------	0-10	0.2-0.6	0.22-0.24	6.6-8.4	2-8	Moderate	0.37	5	4L
Southam	10-32	0.06-0.2	0.14-0.20	6.6-8.4	2-8	High------	0.28		
	32-60	0.06-0.6	0.13-0.17	7.4-9.0	2-8	High------	0.28		
2----------	0-9	0.2-0.6	0.18-0.22	6.1-7.8	<2	Moderate	0.28	5	7
Parnell	9-44	0.06-0.2	0.13-0.19	6.1-7.8	<2	High------	0.28		
	44-60	0.06-0.2	0.11-0.19	6.6-8.4	<2	High------	0.28		
3----------	0-15	0.6-2.0	0.18-0.23	5.6-7.8	<2	Low-------	0.32	5	6
Tonka	15-29	0.2-0.6	0.14-0.19	5.6-7.8	<2	High------	0.43		
	29-60	0.2-0.6	0.14-0.19	6.6-9.0	<2	Moderate	0.43		
4----------	0-7	0.06-0.2	0.20-0.22	6.1-8.4	2-4	Moderate	0.32	3	6
Manfred	7-60	0.06-0.2	0.09-0.13	7.9-9.0	2-16	High------	0.32		
7----------	0-7	0.6-2.0	0.20-0.22	7.4-9.0	<2	Moderate	0.32	5	4L
Colvin	7-36	0.2-0.6	0.16-0.20	7.4-9.0	<2	Moderate	0.32		
	36-60	0.2-0.6	0.15-0.20	7.4-9.0	<2	Moderate	0.32		
8----------	0-1	6.0-20	0.05-0.10	7.4-8.4	2-4	Low-------	0.17	5	2
Minnewaukan	1-60	6.0-20	0.05-0.10	7.4-8.4	2-4	Low-------	0.15		
9*:									
Lallie----------	0-5	0.06-0.2	0.18-0.20	6.6-9.0	4-16	Moderate	0.37	5	6
	5-60	0.06-0.2	0.10-0.19	7.4-9.0	4-16	High------	0.37		
Minnewaukan-----	0-1	6.0-20	0.05-0.10	7.4-8.4	2-4	Low-------	0.17	5	2
	1-60	6.0-20	0.05-0.10	7.4-8.4	2-4	Low-------	0.15		
10*:									
Colvin----------	0-7	0.6-2.0	0.15-0.17	7.4-9.0	4-16	Moderate	0.32	5	4L
	7-60	0.2-0.6	0.11-0.15	7.4-9.0	4-16	Moderate	0.32		
Arveson---------	0-11	2.0-6.0	0.16-0.18	7.4-8.4	4-16	Low-------	0.24	4	4L
	11-26	2.0-6.0	0.15-0.17	7.4-8.4	4-16	Low-------	0.24		
	26-41	2.0-20	0.05-0.15	7.4-8.4	4-16	Low-------	0.17		
	41-60	0.2-0.6	0.15-0.19	7.4-8.4	4-16	Moderate	0.24		
17*:									
Vallers---------	0-12	0.6-2.0	0.14-0.16	7.4-8.4	4-16	Low-------	0.28	5	4L
	12-24	0.2-0.6	0.10-0.13	7.4-8.4	4-16	Low-------	0.28		
	24-60	0.2-0.6	0.11-0.13	7.4-8.4	4-16	Low-------	0.28		
Hamerly---------	0-9	0.6-2.0	0.12-0.15	7.4-8.4	4-16	Moderate	0.28	5	4L
	9-30	0.6-2.0	0.10-0.13	7.4-8.4	4-16	Moderate	0.28		
	30-60	0.2-0.6	0.10-0.13	7.4-8.4	4-16	Moderate	0.37		
21----------	0-20	0.6-2.0	0.20-0.24	6.1-7.8	<2	Low-------	0.28	5	6
Svea	20-25	0.6-2.0	0.17-0.22	6.6-7.8	<2	Moderate	0.28		
	25-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
Svea----------	0-20	0.6-2.0	0.20-0.24	6.1-7.8	<2	Low-------	0.28	5	6
	20-25	0.6-2.0	0.17-0.22	6.6-7.8	<2	Moderate	0.28		
	25-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors		Wind erodibility group
							K	T	
	In	In/hr	In/in	pH	mmhos/cm				
22*:									
Barnes	0-9	0.6-2.0	0.13-0.24	5.6-7.8	<2	Low	0.28	5	6
	9-20	0.6-2.0	0.15-0.19	6.1-7.8	<4	Moderate	0.28		
	20-60	0.2-0.6	0.14-0.19	7.4-8.4	<4	Moderate	0.37		
23*:									
Hamerly	0-9	0.6-2.0	0.18-0.24	6.6-8.4	<2	Moderate	0.28	5	4L
	9-30	0.6-2.0	0.15-0.19	7.4-8.4	<2	Moderate	0.28		
	30-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
Wyard	0-24	0.6-2.0	0.20-0.24	6.6-7.8	<2	Moderate	0.28	5	6
	24-60	0.6-2.0	0.14-0.22	7.4-8.4	<2	Moderate	0.37		
24*:									
Hamerly	0-9	0.6-2.0	0.18-0.24	6.6-8.4	<2	Moderate	0.28	5	4L
	9-30	0.6-2.0	0.15-0.19	7.4-8.4	<2	Moderate	0.28		
	30-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
Parnell	0-9	0.2-0.6	0.18-0.22	6.1-7.8	<2	Moderate	0.28	5	7
	9-44	0.06-0.2	0.13-0.19	6.1-7.8	<2	High	0.28		
	44-60	0.06-0.2	0.11-0.19	6.6-8.4	<2	High	0.28		
25B*:									
Barnes	0-9	0.6-2.0	0.13-0.24	5.6-7.8	<2	Low	0.28	5	6
	9-20	0.6-2.0	0.15-0.19	6.1-7.8	<4	Moderate	0.28		
	20-60	0.2-0.6	0.14-0.19	7.4-8.4	<4	Moderate	0.37		
Maddock	0-8	6.0-20	0.13-0.18	6.1-7.8	<2	Low	0.17	5	3
	8-41	6.0-20	0.05-0.13	6.1-7.8	<2	Low	0.17		
	41-60	0.2-0.6	0.12-0.18	6.1-8.4	<2	Low	0.24		
26B*:									
Barnes	0-9	0.6-2.0	0.13-0.24	5.6-7.8	<2	Low	0.28	5	6
	9-20	0.6-2.0	0.15-0.19	6.1-7.8	<4	Moderate	0.28		
	20-60	0.2-0.6	0.14-0.19	7.4-8.4	<4	Moderate	0.37		
Svea	0-20	0.6-2.0	0.20-0.24	6.1-7.8	<2	Low	0.28	5	6
	20-25	0.6-2.0	0.17-0.22	6.6-7.8	<2	Moderate	0.28		
	25-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
27B*, 27C*, 28F*:									
Barnes	0-9	0.6-2.0	0.13-0.24	5.6-7.8	<2	Low	0.28	5	6
	9-20	0.6-2.0	0.15-0.19	6.1-7.8	<4	Moderate	0.28		
	20-60	0.2-0.6	0.14-0.19	7.4-8.4	<4	Moderate	0.37		
Buse	0-7	0.2-0.6	0.17-0.22	6.6-8.4	<2	Low	0.28	5	4L
	7-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
29D*:									
Buse	0-7	0.2-0.6	0.17-0.22	6.6-8.4	<2	Low	0.28	5	4L
	7-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
Svea	0-20	0.6-2.0	0.20-0.24	6.1-7.8	<2	Low	0.28	5	6
	20-25	0.6-2.0	0.17-0.22	6.6-7.8	<2	Moderate	0.28		
	25-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
30C*:									
Barnes	0-9	0.6-2.0	0.13-0.24	5.6-7.8	<2	Low	0.28	5	6
	9-20	0.6-2.0	0.15-0.19	6.1-7.8	<4	Moderate	0.28		
	20-60	0.2-0.6	0.14-0.19	7.4-8.4	<4	Moderate	0.37		

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors		Wind erodibility group
							K	T	
	In	In/hr	In/in	pH	mmhos/cm				
30C*:									
Maddock	0-12	6.0-20	0.13-0.18	6.6-7.8	<2	Low	0.17	5	3
	12-60	6.0-20	0.05-0.13	6.6-8.4	<2	Low	0.17		
Swenoda	0-11	2.0-6.0	0.11-0.17	6.1-7.3	<2	Low	0.20	5	3
	11-37	2.0-6.0	0.11-0.17	6.6-7.8	<2	Low	0.20		
	37-60	0.2-0.6	0.17-0.20	7.4-8.4	<4	Moderate	0.37		
31*:									
Fram	0-8	0.6-2.0	0.20-0.24	7.4-8.4	<2	Low	0.28	5	4L
	8-60	0.6-2.0	0.13-0.20	7.4-8.4	<2	Low	0.37		
Parnell	0-9	0.2-0.6	0.18-0.22	6.1-7.8	<2	Moderate	0.28	5	7
	9-44	0.06-0.2	0.13-0.19	6.1-7.8	<2	High	0.28		
	44-60	0.06-0.2	0.11-0.19	6.6-8.4	<2	High	0.28		
33*:									
Fram	0-8	0.6-2.0	0.20-0.24	7.4-8.4	<2	Low	0.28	5	4L
	8-60	0.6-2.0	0.13-0.20	7.4-8.4	<2	Low	0.37		
Wyard	0-24	0.6-2.0	0.20-0.24	6.6-7.8	<2	Moderate	0.28	5	6
	24-60	0.6-2.0	0.14-0.22	7.4-8.4	<2	Moderate	0.37		
36*, 36B*:									
Heimdal	0-7	0.6-2.0	0.20-0.24	6.1-7.3	<2	Low	0.28	5	5
	7-14	0.6-2.0	0.17-0.19	6.6-7.8	<2	Low	0.28		
	14-60	0.6-2.0	0.11-0.21	7.9-8.4	<2	Low	0.37		
Emrick	0-16	0.6-2.0	0.20-0.24	6.6-7.8	<2	Low	0.28	5	5
	16-22	0.6-2.0	0.17-0.19	6.6-7.8	<2	Low	0.28		
	22-60	0.6-2.0	0.11-0.21	7.4-8.4	<2	Low	0.37		
37B*, 37C*, 38F*, 39D*:									
Heimdal	0-7	0.6-2.0	0.20-0.24	6.1-7.3	<2	Low	0.28	5	5
	7-14	0.6-2.0	0.17-0.19	6.6-7.8	<2	Low	0.28		
	14-60	0.6-2.0	0.11-0.21	7.9-8.4	<2	Low	0.37		
Esmond	0-7	0.6-2.0	0.20-0.22	7.4-8.4	<2	Low	0.28	5	4L
	7-60	0.6-2.0	0.14-0.22	7.4-8.4	<2	Low	0.37		
41B	0-17	2.0-6.0	0.13-0.18	6.6-7.3	<2	Low	0.20	5	3
Embden	17-40	2.0-6.0	0.12-0.17	6.6-7.8	<2	Low	0.20		
	40-60	2.0-6.0	0.06-0.16	6.6-8.4	<2	Low	0.20		
42*:									
Wyndmere	0-11	2.0-6.0	0.13-0.18	7.4-8.4	<2	Low	0.20	5	3
	11-29	2.0-6.0	0.12-0.17	7.4-8.4	<2	Low	0.20		
	29-55	2.0-6.0	0.06-0.16	7.4-8.4	<2	Low	0.20		
	55-60	0.2-0.6	0.14-0.22	7.4-8.4	<2	Moderate	0.28		
Arveson	0-11	2.0-6.0	0.16-0.18	7.4-8.4	<2	Low	0.24	4	4L
	11-26	2.0-6.0	0.15-0.17	7.4-8.4	<2	Low	0.24		
	26-41	2.0-20	0.05-0.15	7.4-8.4	<2	Low	0.17		
	41-60	0.2-0.6	0.15-0.19	7.4-8.4	<2	Moderate	0.24		
51	0-8	0.2-0.6	0.17-0.23	7.4-8.4	<4	Moderate	0.28	5	4L
Bearden	8-35	0.2-0.6	0.16-0.22	7.4-8.4	<4	Moderate	0.28		
	35-51	0.2-0.6	0.16-0.22	7.4-8.4	<4	Moderate	0.43		
	51-60	6.0-20	0.05-0.09	7.4-8.4	<8	Low	0.15		

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors		Wind erodibility group
							K	T	
	In	In/hr	In/in	pH	mmhos/cm				
52	0-13	0.6-2.0	0.20-0.23	7.4-9.0	<4	Low	0.28	5	4L
Glyndon	13-33	0.6-2.0	0.17-0.20	7.9-9.0	<4	Low	0.28		
	33-43	0.6-2.0	0.15-0.22	7.4-8.4	<4	Low	0.28		
	43-60	0.6-2.0	0.16-0.22	7.4-8.4	<4	Low	0.28		
60*:									
Cathay	0-8	0.6-2.0	0.20-0.23	6.1-7.8	<2	Low	0.32	3	5
	8-18	0.2-0.6	0.16-0.19	6.6-8.4	4-8	Moderate	0.32		
	18-60	0.6-2.0	0.17-0.19	7.4-9.0	4-8	Moderate	0.32		
Heimdal	0-7	0.6-2.0	0.20-0.24	6.1-7.3	<2	Low	0.28	5	5
	7-14	0.6-2.0	0.17-0.19	6.6-7.8	<2	Low	0.28		
	14-60	0.6-2.0	0.11-0.21	7.9-8.4	<2	Low	0.37		
60B*:									
Heimdal	0-7	0.6-2.0	0.20-0.24	6.1-7.3	<2	Low	0.28	5	5
	7-14	0.6-2.0	0.17-0.19	6.6-7.8	<2	Low	0.28		
	14-60	0.6-2.0	0.11-0.21	7.9-8.4	<2	Low	0.37		
Cathay	0-8	0.6-2.0	0.20-0.23	6.1-7.8	<2	Low	0.32	3	5
	8-18	0.2-0.6	0.16-0.19	6.6-8.4	4-8	Moderate	0.32		
	18-60	0.6-2.0	0.17-0.19	7.4-9.0	4-8	Moderate	0.32		
61*:									
Larson	0-11	0.6-2.0	0.16-0.24	6.1-7.3	<2	Moderate	0.32	3	5
	11-23	0.06-0.2	0.10-0.14	7.4-9.0	4-16	Moderate	0.32		
	23-60	0.2-2.0	0.12-0.16	7.9-9.0	2-8	Moderate	0.32		
Cathay	0-8	0.6-2.0	0.20-0.23	6.1-7.8	<2	Low	0.32	3	5
	8-18	0.2-0.6	0.16-0.19	6.6-8.4	4-8	Moderate	0.32		
	18-60	0.6-2.0	0.17-0.19	7.4-9.0	4-8	Moderate	0.32		
62*:									
Miranda	0-4	0.6-2.0	0.18-0.20	6.1-7.3	<2	Low	0.32	3	6
	4-15	<0.06	0.14-0.18	6.6-8.4	2-8	Moderate	0.32		
	15-60	<0.06	0.13-0.17	7.9-9.0	4-16	Moderate	0.32		
Larson	0-11	0.6-2.0	0.16-0.24	6.1-7.3	<2	Moderate	0.32	3	5
	11-23	0.06-0.2	0.10-0.14	7.4-9.0	4-16	Moderate	0.32		
	23-60	0.2-2.0	0.12-0.16	7.9-9.0	2-8	Moderate	0.32		
67	0-15	0.6-2.0	0.11-0.17	5.1-7.8	<2	Low	0.20	3	3
Letcher	15-22	0.6-2.0	0.10-0.15	5.1-7.8	<2	Low	0.24		
	22-36	0.06-0.2	0.08-0.14	6.6-9.0	2-8	Low	0.24		
	36-60	2.0-6.0	0.11-0.18	7.4-9.0	2-8	Low	0.24		
71	0-8	0.6-2.0	0.18-0.22	6.1-7.3	<2	Low	0.24	4	6
Spottswood	8-25	0.6-2.0	0.18-0.22	6.6-7.8	<2	Moderate	0.24		
	25-60	6.0-20	0.03-0.06	7.4-9.0	<2	Low	0.10		
72	0-10	0.6-2.0	0.18-0.22	7.4-8.4	<2	Low	0.28	4	4L
Divide	10-26	0.6-2.0	0.16-0.19	7.4-8.4	<2	Low	0.28		
	26-60	>20	0.03-0.07	7.4-8.4	<2	Low	0.10		
77B	0-11	2.0-6.0	0.13-0.15	6.6-8.4	<2	Low	0.20	3	3
Arvilla	11-18	2.0-6.0	0.11-0.14	6.6-8.4	<2	Low	0.20		
	18-60	>20	0.02-0.05	7.4-8.4	<2	Low	0.10		

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors		Wind erodibility group
							K	T	
	In	In/hr	In/in	pH	mmhos/cm				
78C*:									
Sioux	0-7	2.0-6.0	0.18-0.20	6.6-8.4	<2	Low	0.28	2	5
	7-13	2.0-6.0	0.10-0.15	7.4-8.4	<2	Low	0.20		
	13-60	>20	0.03-0.06	7.4-8.4	<2	Low	0.10		
Arvilla	0-11	2.0-6.0	0.13-0.15	6.6-8.4	<2	Low	0.20	3	3
	11-18	2.0-6.0	0.11-0.14	6.6-8.4	<2	Low	0.20		
	18-60	>20	0.02-0.05	7.4-8.4	<2	Low	0.10		
78F*:									
Coe	0-5	0.6-2.0	0.18-0.22	6.6-7.8	<2	Low	0.28	2	5
	5-60	>20	0.02-0.05	7.4-8.4	<2	Low	0.15		
Heimdal	0-7	0.6-2.0	0.20-0.24	6.1-7.3	<2	Low	0.28	5	5
	7-14	0.6-2.0	0.17-0.19	6.6-7.8	<2	Low	0.28		
	14-60	0.6-2.0	0.11-0.21	7.9-8.4	<2	Low	0.37		
80*:									
Towner	0-14	6.0-20	0.13-0.18	6.6-7.8	<2	Low	0.20	5	3
	14-34	6.0-20	0.06-0.13	6.6-7.8	<2	Low	0.20		
	34-60	0.2-0.6	0.14-0.22	7.4-8.4	<2	Moderate	0.37		
Barnes	0-9	0.6-2.0	0.13-0.15	5.6-7.8	<2	Low	0.20	5	3
	9-20	0.6-2.0	0.15-0.19	6.1-7.8	<4	Moderate	0.28		
	20-60	0.2-0.6	0.14-0.19	7.4-8.4	<4	Moderate	0.37		
81	0-12	6.0-20	0.14-0.17	6.1-7.8	<2	Low	0.20	5	3
Hecla	12-38	6.0-20	0.10-0.12	6.1-7.8	<2	Low	0.17		
	38-51	6.0-20	0.06-0.10	6.1-8.4	<2	Low	0.17		
	51-60	0.6-2.0	0.14-0.19	7.4-8.4	<2	Moderate	0.28		
82B	0-14	6.0-20	0.08-0.12	6.6-7.8	<2	Low	0.17	5	2
Towner	14-34	6.0-20	0.06-0.13	6.6-7.8	<2	Low	0.17		
	34-60	0.2-0.6	0.14-0.22	7.4-8.4	<2	Moderate	0.37		
84B	0-11	6.0-20	0.08-0.10	6.6-7.8	<2	Low	0.15	5	2
Lohnes	11-20	6.0-20	0.03-0.07	6.6-7.8	<2	Low	0.15		
	20-60	6.0-20	0.03-0.07	7.4-8.4	<2	Low	0.15		
86B	0-12	6.0-20	0.08-0.12	6.6-7.8	<2	Low	0.17	5	2
Maddock	12-60	6.0-20	0.05-0.13	6.6-8.4	<2	Low	0.17		
89D*:									
Maddock	0-12	6.0-20	0.08-0.12	6.6-7.8	<2	Low	0.17	5	2
	12-60	6.0-20	0.05-0.13	6.6-8.4	<2	Low	0.17		
Barnes	0-9	0.6-2.0	0.13-0.24	5.6-7.8	<2	Low	0.28	5	6
	9-20	0.6-2.0	0.15-0.19	6.1-7.8	<4	Moderate	0.28		
	20-60	0.2-0.6	0.14-0.19	7.4-8.4	<4	Moderate	0.37		
Towner	0-14	6.0-20	0.08-0.12	6.6-7.8	<2	Low	0.17	5	2
	14-34	6.0-20	0.06-0.13	6.6-7.8	<2	Low	0.17		
	34-60	0.2-0.6	0.14-0.22	7.4-8.4	<2	Moderate	0.37		
90*:									
Ulen	0-9	2.0-6.0	0.13-0.18	7.4-8.4	<4	Low	0.17	5	3
	9-42	6.0-20	0.06-0.10	7.9-8.4	<4	Low	0.17		
	42-60	6.0-20	0.06-0.08	7.4-8.4	<4	Low	0.17		

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors		Wind erodibility group
							K	T	
	In	In/hr	In/in	pH	mmhos/cm				
90*:									
Hecla	0-12	6.0-20	0.14-0.17	6.1-7.8	<2	Low	0.20	5	3
	12-38	6.0-20	0.10-0.12	6.1-7.8	<2	Low	0.17		
	38-60	6.0-20	0.06-0.10	6.1-8.4	<2	Low	0.17		
91B	0-11	2.0-6.0	0.11-0.17	6.1-7.3	<2	Low	0.20	5	3
Swenoda	11-37	2.0-6.0	0.11-0.17	6.6-7.8	<2	Low	0.20		
	37-60	0.2-0.6	0.17-0.20	7.4-8.4	<4	Moderate	0.37		
95*:									
Colvin	0-7	0.6-2.0	0.20-0.22	7.4-9.0	<2	Moderate	0.32	5	4L
	7-36	0.2-0.6	0.16-0.20	7.4-9.0	<2	Moderate	0.32		
	36-60	0.2-0.6	0.16-0.20	7.4-9.0	<2	Moderate	0.32		
La Prairie	0-8	0.6-2.0	0.17-0.22	6.6-8.4	<2	Low	0.28	5	6
	8-24	0.6-2.0	0.17-0.22	6.6-8.4	<2	Moderate	0.28		
	24-50	0.6-2.0	0.15-0.22	6.6-8.4	<2	Moderate	0.28		
	50-60	0.6-2.0	0.15-0.22	6.6-8.4	<2	Moderate	0.28		
96	0-8	0.6-2.0	0.17-0.22	6.6-8.4	<2	Low	0.28	5	6
La Prairie	8-24	0.6-2.0	0.17-0.22	6.6-8.4	<2	Moderate	0.28		
	24-50	0.6-2.0	0.15-0.22	6.6-8.4	<2	Moderate	0.28		
	50-60	0.6-2.0	0.15-0.22	6.6-8.4	<2	Moderate	0.28		
99*.									
Pits									
102	0-8	2.0-6.0	0.13-0.18	5.6-7.8	<2	Low	0.17	5	3
Kratka	8-32	2.0-6.0	0.06-0.11	5.6-7.8	<2	Low	0.17		
	32-60	0.2-0.6	0.11-0.19	7.4-8.4	<2	Moderate	0.32		

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 16.--SOIL AND WATER FEATURES

("Flooding" and "water table" and terms such as "rare," "brief," "apparent," and "perched" are explained in the text. The symbol < means less than; > means more than. Absence of an entry indicates that the feature is not a concern or that data were not estimated)

Soil name and map symbol	Hydrologic group	Flooding			High water table			Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months		Uncoated steel	Concrete
					Ft					
1---------- Southam	D	None	---	---	+5-1.0	Apparent	Jan-Dec	High	High	Low.
2---------- Parnell	C/D	None	---	---	+2-2.0	Apparent	Jan-Dec	High	High	Low.
3---------- Tonka	C/D	None	---	---	+.5-1.0	Apparent	Apr-Jun	High	High	Low.
4---------- Manfred	D	None	---	---	+1-1.0	Apparent	Mar-Aug	High	High	Low.
7---------- Colvin	C/D	None	---	---	+1-1.0	Apparent	Jan-Dec	High	High	Low.
8---------- Minnewaukan	A/D	None	---	---	0-2.5	Apparent	Apr-Jun	Moderate	High	Low.
9*:										
Lallie----------	D	None	---	---	+1-1.0	Apparent	Apr-Jun	High	High	Low.
Minnewaukan------	A/D	None	---	---	0-2.5	Apparent	Apr-Jun	Moderate	High	Low.
10*:										
Colvin----------	C/D	None	---	---	0-2.0	Apparent	Apr-Jul	High	High	Moderate.
Arveson----------	B/D	None	---	---	0-2.0	Apparent	Apr-Jul	High	High	Low.
17*:										
Vallers----------	C	None	---	---	0-1.0	Apparent	Apr-Jul	High	High	Moderate.
Hamerly----------	C	None	---	---	2.0-4.0	Apparent	Sep-Jun	High	High	Moderate.
21---------- Svea	B	None	---	---	4.0-6.0	Apparent	Apr-Jun	Moderate	High	Low.
22*:										
Svea----------	B	None	---	---	4.0-6.0	Apparent	Apr-Jun	Moderate	High	Low.
Barnes----------	B	None	---	---	>6.0	---	---	Moderate	High	Low.
23*:										
Hamerly----------	C	None	---	---	2.0-4.0	Apparent	Apr-Jun	High	High	Low.
Wyard----------	B	None	---	---	1.0-3.0	Apparent	Mar-Jun	High	High	Low.
24*:										
Hamerly----------	C	None	---	---	2.0-4.0	Apparent	Apr-Jun	High	High	Low.
Parnell----------	C/D	None	---	---	+2-2.0	Apparent	Jan-Dec	High	High	Low.
25B*:										
Barnes----------	B	None	---	---	>6.0	---	---	Moderate	High	Low.
Maddock----------	A	None	---	---	>6.0	---	---	Low	High	Low.

See footnote at end of table.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months		Uncoated steel	Concrete
					Ft					
26B*:										
Barnes	B	None	---	---	>6.0	---	---	Moderate	High	Low.
Svea	B	None	---	---	4.0-6.0	Apparent	Apr-Jun	Moderate	High	Low.
27B*, 27C*, 28F*:										
Barnes	B	None	---	---	>6.0	---	---	Moderate	High	Low.
Buse	B	None	---	---	>6.0	---	---	Moderate	Low	Low.
29D*:										
Buse	B	None	---	---	>6.0	---	---	Moderate	Low	Low.
Svea	B	None	---	---	>6.0	---	---	Moderate	High	Low.
30C*:										
Barnes	B	None	---	---	>6.0	---	---	Moderate	High	Low.
Maddock	A	None	---	---	>6.0	---	---	Low	Moderate	Low.
Swenoda	B	None	---	---	2.5-4.0	Perched	Mar-Jun	Moderate	High	Moderate.
31*:										
Fram	B	None	---	---	2.0-6.0	Apparent	Sep-Jun	High	High	Low.
Parnell	C/D	None	---	---	+2-2.0	Apparent	Jan-Dec	High	High	Low.
33*:										
Fram	B	None	---	---	2.0-6.0	Apparent	Sep-Jun	High	High	Low.
Wyard	B	None	---	---	1.0-3.0	Apparent	Mar-Jun	High	High	Low.
36*, 36B*:										
Heimdal	B	None	---	---	>6.0	---	---	Moderate	High	Low.
Emrick	B	None	---	---	>6.0	---	---	Moderate	High	Low.
37B*, 37C*, 38F*, 39D*:										
Heimdal	B	None	---	---	>6.0	---	---	Moderate	High	Low.
Esmond	B	None	---	---	>6.0	---	---	Moderate	High	Low.
41B---------- Embden	B	None	---	---	4.0-6.0	Apparent	Apr-Jun	Moderate	High	Low.
42*:										
Wyndmere	B	None	---	---	2.0-5.0	Apparent	Sep-Jun	High	High	Low.
Arveson	B/D	None	---	---	0-2.0	Apparent	Apr-Jul	High	High	Low.
51---------- Bearden	C	None	---	---	2.0-4.0	Apparent	Apr-Jun	High	High	Low.
52---------- Glyndon	B	None	---	---	2.5-6.0	Apparent	Apr-Jul	High	High	Low.
60*:										
Cathay	C	None	---	---	3.0-5.0	Apparent	Apr-Jun	Moderate	High	Moderate.
Heimdal	B	None	---	---	>6.0	---	---	Moderate	High	Low.

See footnote at end of table.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months		Uncoated steel	Concrete
					Ft					
60B*:										
Heimdal	B	None	---	---	>6.0	---	---	Moderate	High	Low.
Cathay	C	None	---	---	3.0-5.0	Apparent	Apr-Jun	Moderate	High	Moderate.
61*:										
Larson	D	None	---	---	3.0-6.0	Apparent	Mar-Jun	Moderate	High	Moderate.
Cathay	C	None	---	---	3.0-5.0	Apparent	Apr-Jun	Moderate	High	Moderate.
62*:										
Miranda	D	None	---	---	2.0-4.0	Apparent	Apr-Jul	Moderate	High	Moderate.
Larson	D	None	---	---	3.0-6.0	Apparent	Mar-Jun	Moderate	High	Moderate.
67--Letcher	D	None	---	---	3.5-6.0	Perched	Nov-Jun	Moderate	High	Moderate.
71--Spottswood	B	None	---	---	3.0-6.0	Apparent	Oct-Jun	Moderate	High	Low.
72--Divide	B	None	---	---	2.5-5.0	Apparent	Apr-Jun	Moderate	High	Low.
77B--Arvilla	B	None	---	---	>6.0	---	---	Low	Moderate	Low.
78C*:										
Sioux	A	None	---	---	>6.0	---	---	Low	Low	Low.
Arvilla	B	None	---	---	>6.0	---	---	Low	Moderate	Low.
78F*:										
Coe	A	None	---	---	>6.0	---	---	Low	Moderate	Low.
Heimdal	B	None	---	---	>6.0	---	---	Moderate	High	Low.
80*:										
Towner	B	None	---	---	3.0-6.0	Perched	Apr-Jun	Moderate	High	Low.
Barnes	B	None	---	---	>6.0	---	---	Moderate	High	Low.
81--Hecla	A	None	---	---	3.0-6.0	Apparent	Apr-Oct	Moderate	Moderate	Low.
82B--Towner	B	None	---	---	3.0-6.0	Perched	Apr-Jun	Moderate	High	Low.
84B--Lohnes	A	None	---	---	>6.0	---	---	Low	Moderate	Low.
86B--Maddock	A	None	---	---	>6.0	---	---	Low	Moderate	Low.
89D*:										
Maddock	A	None	---	---	>6.0	---	---	Low	Moderate	Low.
Barnes	B	None	---	---	>6.0	---	---	Moderate	High	Low.
Towner	B	None	---	---	3.0-6.0	Perched	Apr-Jun	Moderate	High	Low.

See footnote at end of table.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months		Uncoated steel	Concrete
					Ft					
90*:										
Ulen	B	None	---	---	2.5-6.0	Apparent	Apr-Jul	Moderate	Low	Low.
Hecla	A	None	---	---	3.0-6.0	Apparent	Apr-Oct	Moderate	Moderate	Low.
91B--Swenoda	B	None	---	---	2.5-4.0	Perched	Mar-Jun	Moderate	High	Moderate.
95*:										
Colvin	C/D	Frequent	Brief	Mar-Jul	0-1.0	Apparent	Apr-Jul	High	High	Low.
La Prairie	B	Occasional	Brief	Mar-Jun	3.5-6.0	Apparent	Mar-Jun	Moderate	Moderate	Low.
96--La Prairie	B	Rare	---	---	>6.0	---	---	Moderate	Moderate	Low.
99*. Pits										
102--Kratka	B/D	None	---	---	0.5-3.0	Apparent	Apr-Jul	Moderate	High	Low.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 17.--ENGINEERING INDEX TEST DATA

(Dashes indicate that data were not available. LL means liquid limit; PI, plasticity index; MD, maximum dry density; OM, optimum moisture; and NP, nonplastic)

Soil name, report number, horizon, and depth in inches	Classification		Grain-size distribution								LL	PI	Moisture density	
			Percentage passing sieve--					Percentage smaller than--						
	AASHTO	Unified	3/8 inch	No. 4	No. 10	No. 40	No. 200	.02 mm	.005 mm	.002 mm			MD	OM
											Pct		Lb/ cu ft	Pct
Cathay loam: (S86ND031-7)														
Bt----- 8 to 18	A-6(6)	CL	100	100	100	95	64	---	24	---	31	14	122	12
C2----- 47 to 60	A-6(12)	CL	100	99	98	91	61	---	24	---	39	25	127	10
Divide loam: (S86ND031-8)														
Bk----- 10 to 26	A-6(4)	CL	100	100	100	---	60	---	27	---	25	11	127	10
2C----- 30 to 60	A-3(0)	SP-SM	100	100	99	---	9	---	2	---	---	NP	112	15
Emrick loam: (S86ND031-1)														
Bk----- 22 to 43	A-6(1)	SC	97	94	91	80	43	---	15	---	26	11	127	10
C------ 43 to 60	A-4(1)	SC	100	100	100	96	47	---	18	---	25	8	124	11
Fram loam: (S86ND031-4)														
Bk----- 11 to 23	A-4(0)	ML	100	100	97	87	53	---	14	---	20	2	128	10
C------ 39 to 60	A-4(0)	ML	100	100	96	86	51	---	10	---	20	3	130	9
Heimdal loam: (S86ND031-2)														
Bk----- 14 to 32	A-4(3)	CL	97	92	85	76	57	---	19	---	27	10	127	10
C------ 32 to 60	A-6(8)	CL	98	96	93	87	68	---	25	---	33	15	120	13
Kratka fine sandy loam: (S88ND031-85)														
Bg----- 8 to 28	A-2(4)	SM	100	100	100	---	13	---	6	---	0	NP	125	10
2Bkg--- 32 to 45	A-6(8)	CL	100	100	99	---	73	---	25	---	31	14	118	13
Larson loam: (S86ND031-21)														
Bt----- 11 to 23	A-7-6(20)	CL	100	100	100	98	80	---	30	---	43	26	114	15
C------ 33 to 47	A-4(2)	CL	99	99	98	94	52	---	14	---	29	8	121	12
Manfred loam: (S86ND031-6)														
Btg---- 13 to 22	A-7-6(17)	CL	100	100	99	94	65	---	29	---	44	30	123	11
3C----- 46 to 60	A-6(4)	CL	100	99	97	89	58	---	22	---	27	13	128	10

TABLE 18.--CLASSIFICATION OF THE SOILS

(An asterisk in the first column indicates that the soil is a taxadjunct to the series. See text for a description of those characteristics of the soil that are outside the range of the series)

Soil name	Family or higher taxonomic class
Arveson	Coarse-loamy, frigid Typic Calciaquolls
*Arvilla	Sandy, mixed Udic Haploborolls
Barnes	Fine-loamy, mixed Udic Haploborolls
Bearden	Fine-silty, frigid Aeric Calciaquolls
Buse	Fine-loamy, mixed Udorthentic Haploborolls
Cathay	Fine-loamy, mixed Glossic Udic Natriborolls
Coe	Sandy-skeletal, mixed Udorthentic Haploborolls
Colvin	Fine-silty, frigid Typic Calciaquolls
Divide	Fine-loamy over sandy or sandy-skeletal, frigid Aeric Calciaquolls
Embden	Coarse-loamy, mixed Pachic Udic Haploborolls
Emrick	Coarse-loamy, mixed Pachic Udic Haploborolls
Esmond	Coarse-loamy, mixed Udorthentic Haploborolls
Fram	Coarse-loamy, frigid Aeric Calciaquolls
Glyndon	Coarse-silty, frigid Aeric Calciaquolls
Hamerly	Fine-loamy, frigid Aeric Calciaquolls
Hecla	Sandy, mixed Aquic Haploborolls
Heimdal	Coarse-loamy, mixed Udic Haploborolls
Kratka	Sandy over loamy, mixed, frigid Typic Haplaquolls
La Prairie	Fine-loamy, mixed Cumulic Udic Haploborolls
*Lallie	Fine, montmorillonitic (calcareous), frigid Typic Fluvaquents
Larson	Fine-loamy, mixed Udic Natriborolls
Letcher	Coarse-loamy, mixed Udic Natriborolls
Lohnes	Sandy, mixed Udorthentic Haploborolls
Maddock	Sandy, mixed Udorthentic Haploborolls
Manfred	Fine-loamy, mixed, frigid Typic Natraquolls
Minnewaukan	Mixed, frigid Typic Psammaquents
Miranda	Fine-loamy, mixed Leptic Natriborolls
Parnell	Fine, montmorillonitic, frigid Typic Argiaquolls
Sioux	Sandy-skeletal, mixed Udorthentic Haploborolls
Southam	Fine, montmorillonitic (calcareous), frigid Cumulic Haplaquolls
Spottswood	Fine-loamy over sandy or sandy-skeletal, mixed Pachic Udic Haploborolls
Svea	Fine-loamy, mixed Pachic Udic Haploborolls
Swenoda	Coarse-loamy, mixed Pachic Udic Haploborolls
Tonka	Fine, montmorillonitic, frigid Argiaquic Argialbolls
Towner	Sandy over loamy, mixed Udorthentic Haploborolls
Ulen	Sandy, frigid Aeric Calciaquolls
Vallers	Fine-loamy, frigid Typic Calciaquolls
Wyard	Fine-loamy, mixed, frigid Typic Haplaquolls
Wyndmere	Coarse-loamy, frigid Aeric Calciaquolls

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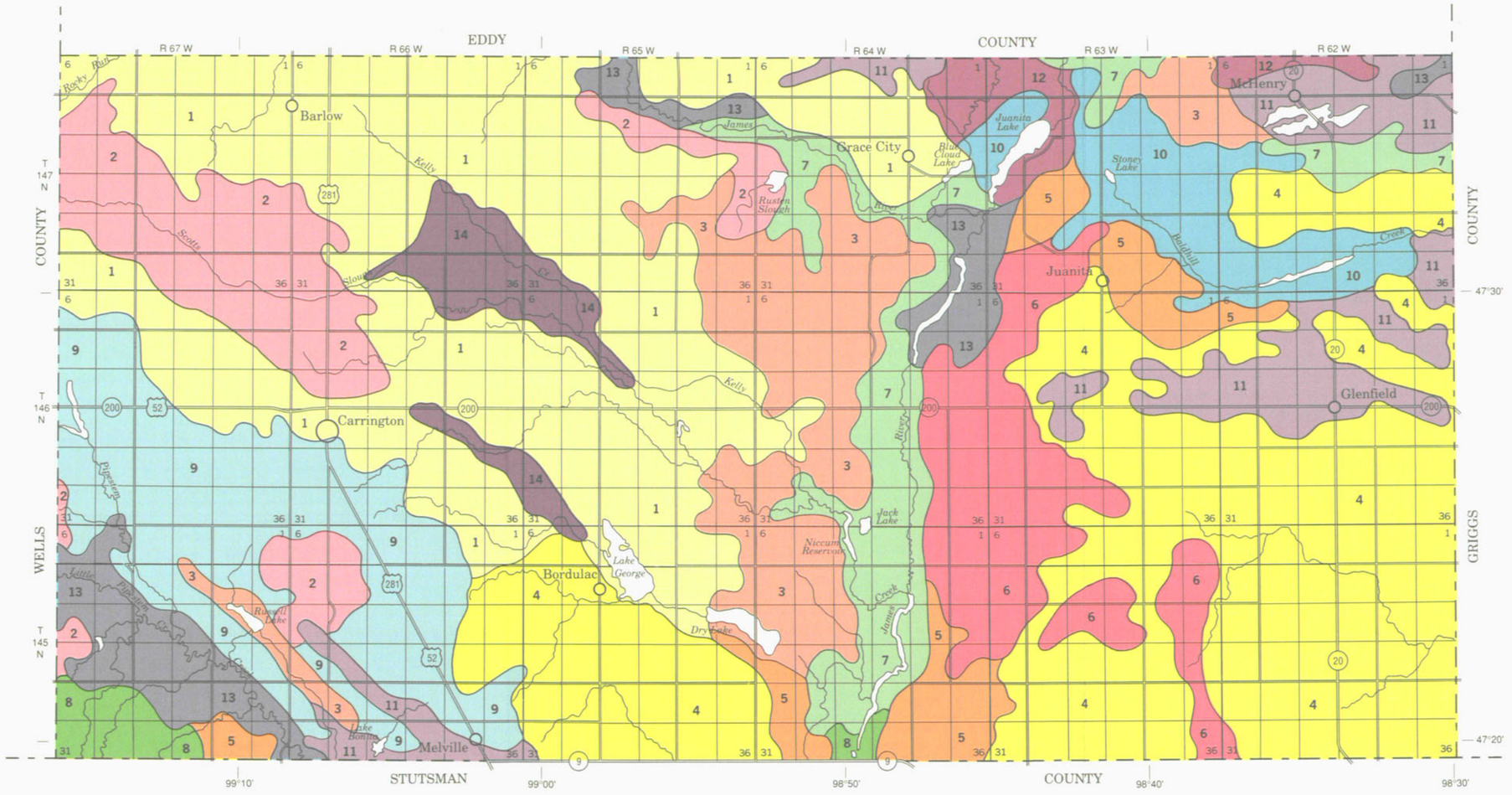


SOIL LEGEND*

DOMINANTLY LEVEL TO ROLLING, LOAMY SOILS

1 Fram-Heimdal-Emrick association

2 Heimdal-Emrick association

3 Heimdal-Emrick-Esmond association

4 Hamerly-Svea association

5 Svea-Barnes association

6 Barnes-Svea-Buse association

DOMINANTLY LEVEL TO STEEP, LOAMY SOILS

7 Heimdal-Esmond-La Prairie association

8 Barnes-Buse association

DOMINANTLY LEVEL TO UNDULATING, LOAMY, SODIC SOILS

9 Cathay-Heimdal-Larson association

DOMINANTLY LEVEL TO ROLLING, LOAMY, SANDY, AND SILTY SOILS

10 Barnes-Maddock association

11 Swenoda-Wyndmere-Hecla association

12 Maddock-Lohnes association

13 Arvilla-Sioux-Colvin association

14 Divide-Fram association

* The units on this legend are described in the text under the heading "General Soil Map Units."

Compiled 1990

N

SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.

UNITED STATES DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE
NORTH DAKOTA AGRICULTURAL EXPERIMENT STATION
NORTH DAKOTA STATE SOIL CONSERVATION COMMITTEE
NORTH DAKOTA COOPERATIVE EXTENSION SERVICE

GENERAL SOIL MAP

FOSTER COUNTY, NORTH DAKOTA

Scale 1:190,080

1 0 1 2 3 Mi

1 0 3 6 Km

EDDY COUNTY

R 67 W | R 66 W | R 65 W | R 64 W | R 63 W | R 62 W

T 147 N

T 146 N

T 145 N

COUNTY

WELLS

STUTSMAN COUNTY

GRIGGS COUNTY

47°30'

47°20'

99°10' | 99°00' | 98°50' | 98°40' | 98°30'

Barlow
Grace City
McHenry
Juanita
Glenfield
Carrington
Bordulac
Melville

Rocky Run
James
Kelly
Blue Cloud Lake
Jewett Lake
Stoney Lake
Rusten Slough
River
Scatts Slough
Cr
Ethiel Creek
Kelly
River
Jack Lake
Niccum Reservoir
Lake George
Dry Lake
James Creek
Little Pipestem
Pipestem
Russell Lake
Creek
Lake Bonita

1 2 3 4 5 6 7 8
9 10 11 12 13 14 15 16
17 18 19 20 21 22 23 24
25 26 27 28 29 30 31 32
33 34 35 36 37 38 39 40
41 42 43 44 45 46 47 48

N

SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

This soil survey map is compiled on 1978 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service, and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

INDEX TO MAP SHEETS

FOSTER COUNTY, NORTH DAKOTA

Scale 1:190,080

1 0 1 2 3 Mi

1 0 3 6 Km

SOIL LEGEND

Map symbols consist of numbers or a combination of numbers and a letter. The initial numbers represent the kind of soil. A capital letter following these numbers indicates the class of slope. Symbols without a slope letter are for level or nearly level soils or miscellaneous areas.

SYMBOL	NAME
1	Southam silt loam
2	Parnell silty clay loam
3	Tonka silt loam
4	Manfred loam
7	Colvin silt loam, wet
8	Minnewaukan loamy fine sand
9	Lallie, saline-Minnewaukan complex
10	Colvin and Arveson, loamy substratum, soils, saline
17	Vallers and Hamerly loams, saline
21	Svea loam, 0 to 2 percent slopes
22	Svea-Barnes loams, 0 to 3 percent slopes
23	Hamerly-Wyard loams, 0 to 3 percent slopes
24	Hamerly-Parnell complex, 0 to 3 percent slopes
25B	Barnes-Maddock, loamy substratum, complex, 3 to 6 percent slopes
26B	Barnes-Svea loams, 3 to 6 percent slopes
27B	Barnes-Buse loams, 3 to 6 percent slopes
27C	Barnes-Buse loams, 6 to 9 percent slopes
28F	Barnes-Buse loams, 15 to 35 percent slopes
29D	Buse-Svea loams, 9 to 15 percent slopes
30C	Barnes-Maddock-Swenoda complex, 6 to 9 percent slopes
31	Fram-Parnell complex, 0 to 3 percent slopes
33	Fram-Wyard loams, 0 to 3 percent slopes
36	Heimdal-Emrick loams, 0 to 3 percent slopes
36B	Heimdal-Emrick loams, 3 to 6 percent slopes
37B	Heimdal-Esmond loams, 3 to 6 percent slopes
37C	Heimdal-Esmond loams, 6 to 9 percent slopes
38F	Heimdal-Esmond loams, 15 to 35 percent slopes
39D	Heimdal-Esmond loams, 9 to 15 percent slopes
41B	Embden fine sandy loam, 0 to 6 percent slopes
42	Wyndmere-Arveson complex, loamy substratum, 0 to 3 percent slopes
51	Bearden silty clay loam, sandy substratum
52	Glyndon loam, 0 to 2 percent slopes
60	Cathay-Heimdal loams, 1 to 3 percent slopes
60B	Heimdal-Cathay loams, 3 to 6 percent slopes
61	Larson-Cathay loams, 0 to 2 percent slopes
62	Miranda-Larson loams, 0 to 2 percent slopes
67	Letcher fine sandy loam, 0 to 3 percent slopes
71	Spottswood loam, 0 to 3 percent slopes
72	Divide loam, 0 to 3 percent slopes
77B	Arvilla sandy loam, 0 to 6 percent slopes
78C	Sioux-Arvilla complex, 1 to 9 percent slopes
78F	Coe-Heimdal loams, 9 to 35 percent slopes
80	Towner-Barnes sandy loams, 0 to 3 percent slopes
81	Hecla fine sandy loam, loamy substratum, 0 to 3 percent slopes
82B	Towner loamy fine sand, 0 to 6 percent slopes
84B	Lohnes loamy coarse sand, 0 to 6 percent slopes
86B	Maddock loamy fine sand, 0 to 6 percent slopes
89D	Maddock-Barnes-Towner complex, 6 to 15 percent slopes
90	Ulen-Hecla fine sandy loams, 0 to 2 percent slopes
91B	Swenoda fine sandy loam, 0 to 6 percent slopes
95	Colvin and La Prairie soils, channeled
96	La Prairie loam
99	Pits, sand and gravel
102	Kratka fine sandy loam

CONVENTIONAL AND SPECIAL SYMBOLS LEGEND

CULTURAL FEATURES

BOUNDARIES

- National, state, or province
- County or parish
- Minor civil division
- Reservation (national forest or park, state forest or park, and large airport)
- Land grant
- Limit of soil survey (label)
- Field sheet matchline and neatline

AD HOC BOUNDARY (label) — Davis Airstrip

Small airport, airfield, park, oilfield, cemetery, or flood pool — FLOOD, POOL, LAKE

STATE COORDINATE TICK
1 890 000 FEET

LAND DIVISION CORNER
(sections and land grants)

ROADS

- Divided (median shown if scale permits)
- Other roads
- Trail

ROAD EMBLEM & DESIGNATIONS

- Interstate — 173
- Federal — 287
- State — 52
- County, farm or ranch — 1283

RAILROAD

POWER TRANSMISSION LINE
(normally not shown)

PIPE LINE (normally not shown)

FENCE (normally not shown)

LEVEES

- Without road
- With road
- With railroad

DAMS

- Large (to scale)
- Medium or Small
(Named where applicable) — water

PITS

- Gravel pit
- Mine or quarry

MISCELLANEOUS CULTURAL FEATURES

- Farmstead, house (omit in urban area) (occupied)
- Church
- School
- Indian mound (label) — Indian Mound
- Located object (label) — Tower
- Tank (label) — Gas
- Wells, oil or gas
- Windmill
- Kitchen midden

WATER FEATURES

DRAINAGE

- Perennial, double line
- Perennial, single line
- Intermittent
- Drainage end
- Canals or ditches
  - Double-line (label) — CANAL
  - Drainage and/or irrigation

LAKES, PONDS AND RESERVOIRS

- Perennial — water
- Intermittent — int

MISCELLANEOUS WATER FEATURES

- Marsh or swamp
- Spring
- Well, artesian
- Well, irrigation
- Wet spot

SPECIAL SYMBOLS FOR SOIL SURVEY

SOIL DELINEATIONS AND SYMBOLS — 4 36B

ESCARPMENTS

- Bedrock (points down slope)
- Other than bedrock (points down slope)

SHORT STEEP SLOPE

GULLY

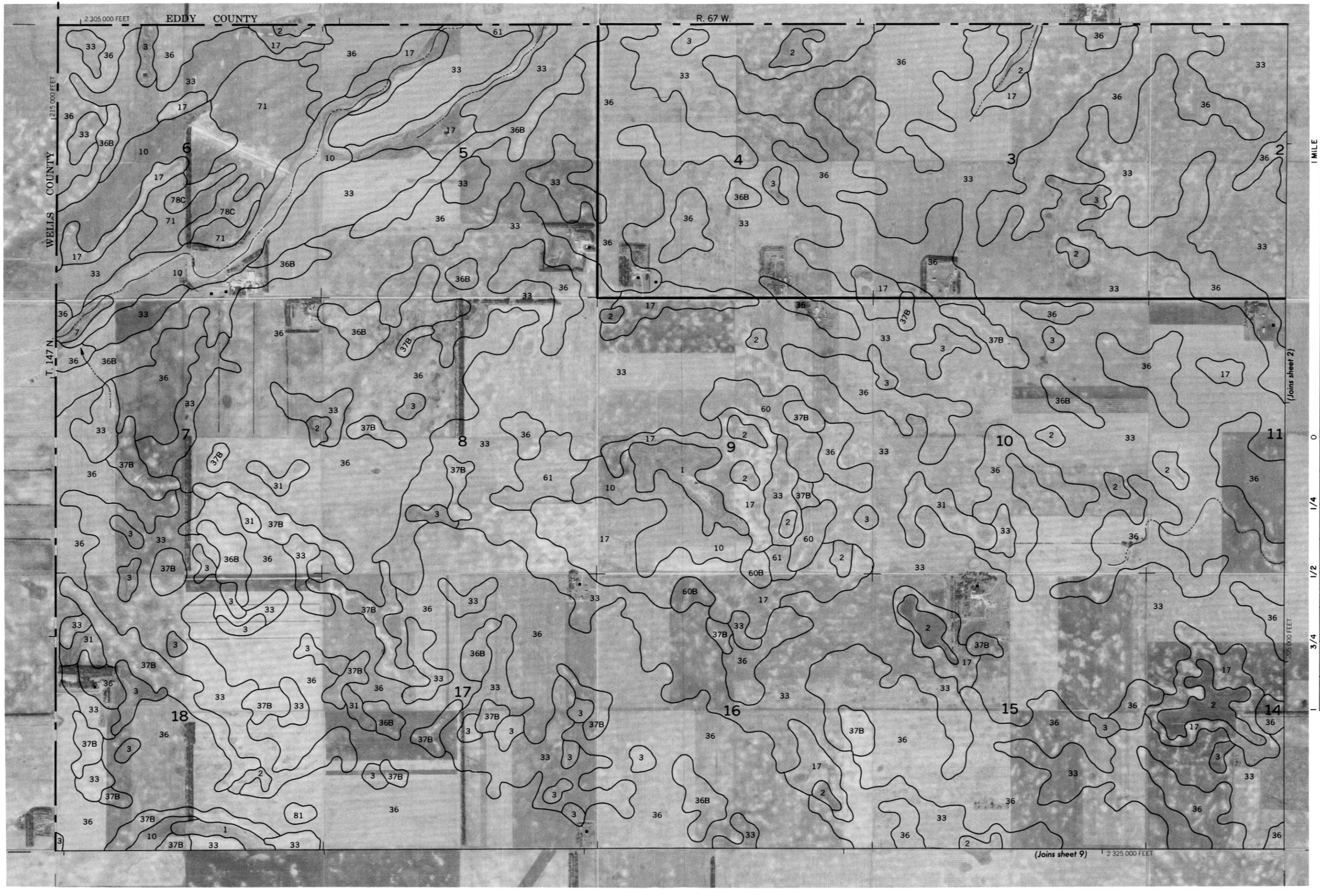
DEPRESSION OR SINK

SOIL SAMPLE (normally not shown) — S

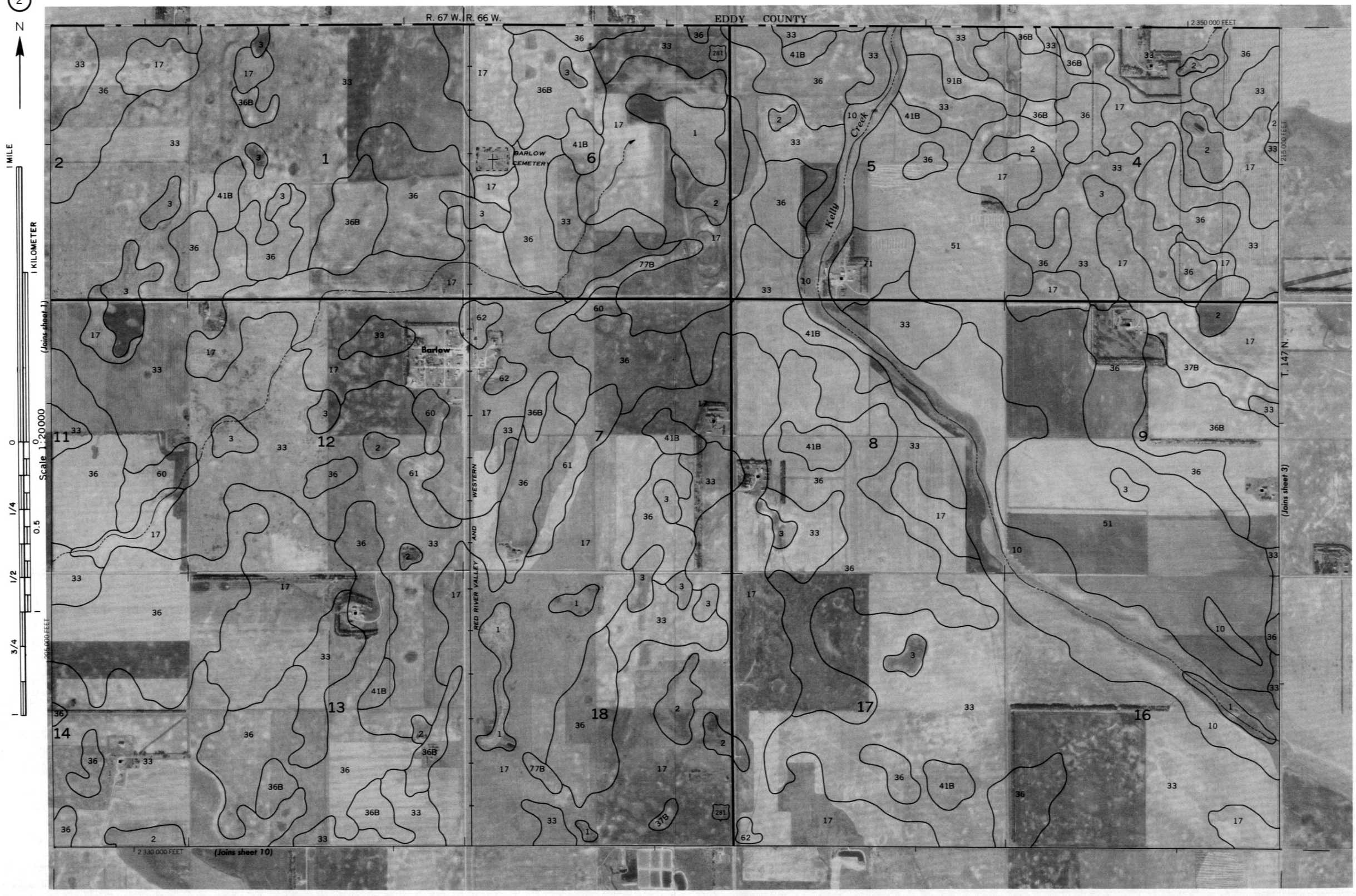
MISCELLANEOUS

- Blowout
- Clay spot
- Gravelly spot
- Gumbo, slick or scabby spot (sodic)
- Dumps and other similar non soil areas
- Prominent hill or peak
- Rock outcrop (includes sandstone and shale)
- Saline spot
- Sandy spot
- Severely eroded spot
- Slide or slip (tips point upslope)
- Stony spot, very stony spot
(5 acres or less)

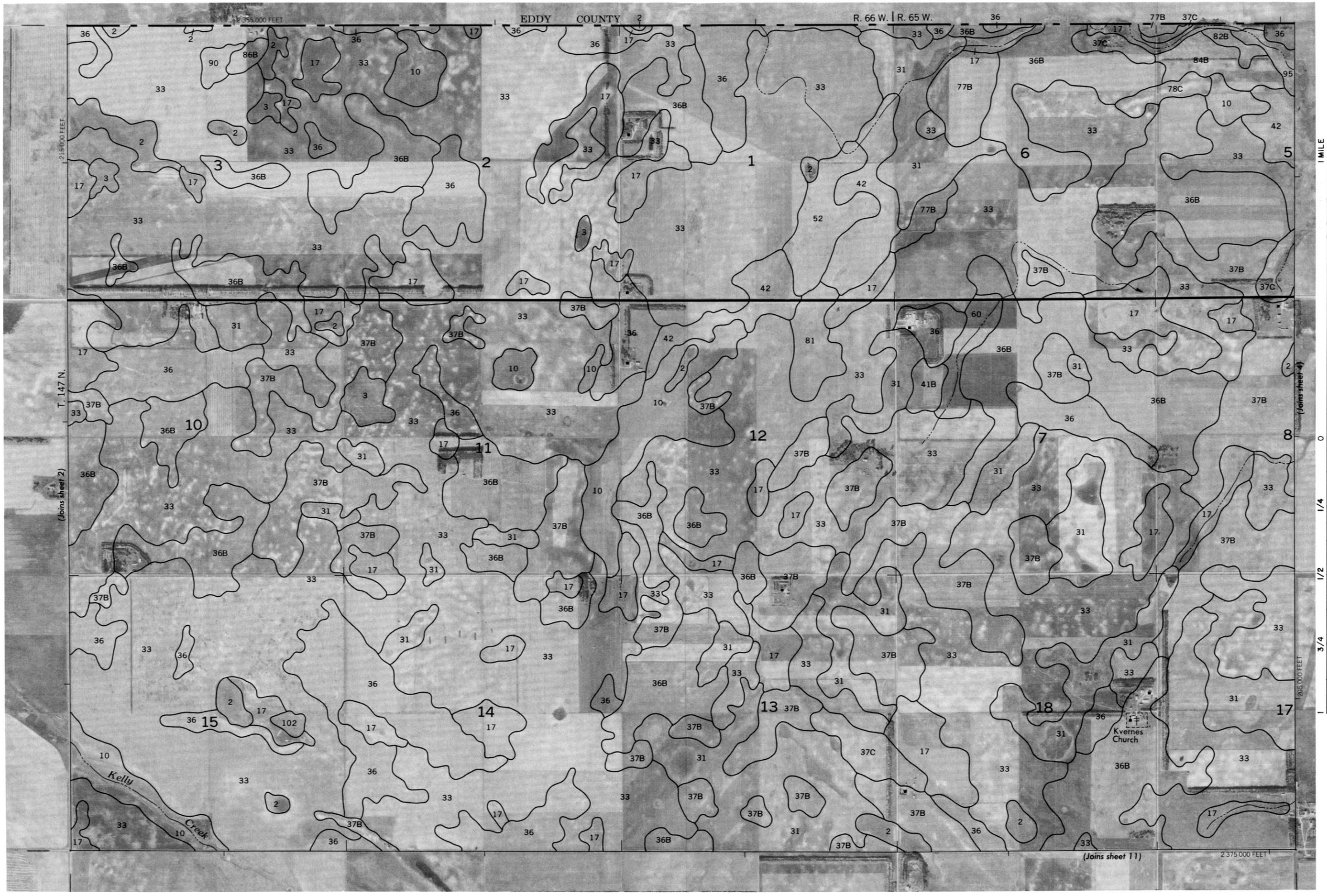
SOIL MAP OF FOSTER COUNTY, NORTH DAKOTA – SHEET NUMBER 1



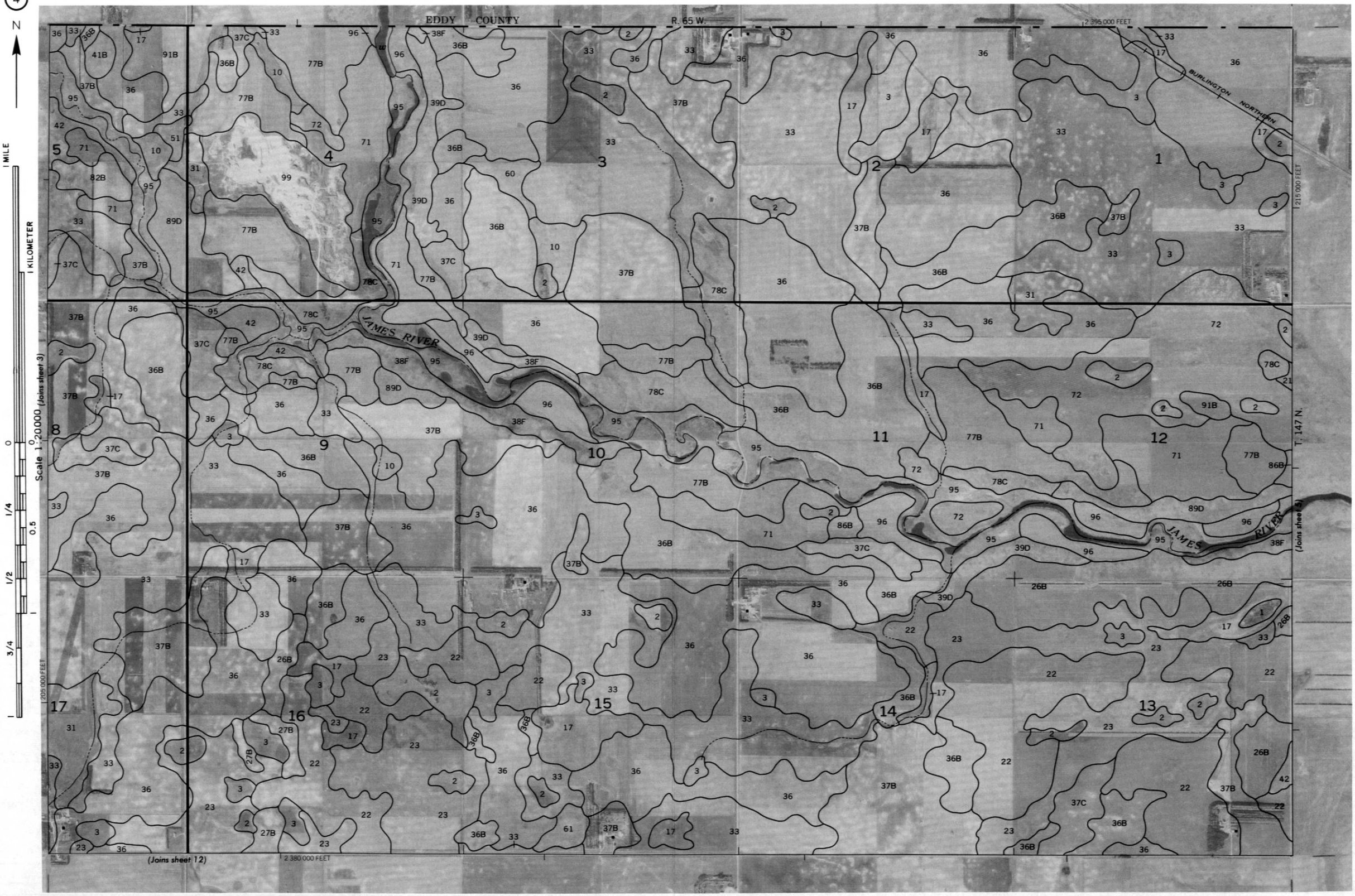
SOIL MAP OF FOSTER COUNTY, NORTH DAKOTA – SHEET NUMBER 2



SOIL MAP OF FOSTER COUNTY, NORTH DAKOTA – SHEET NUMBER 3

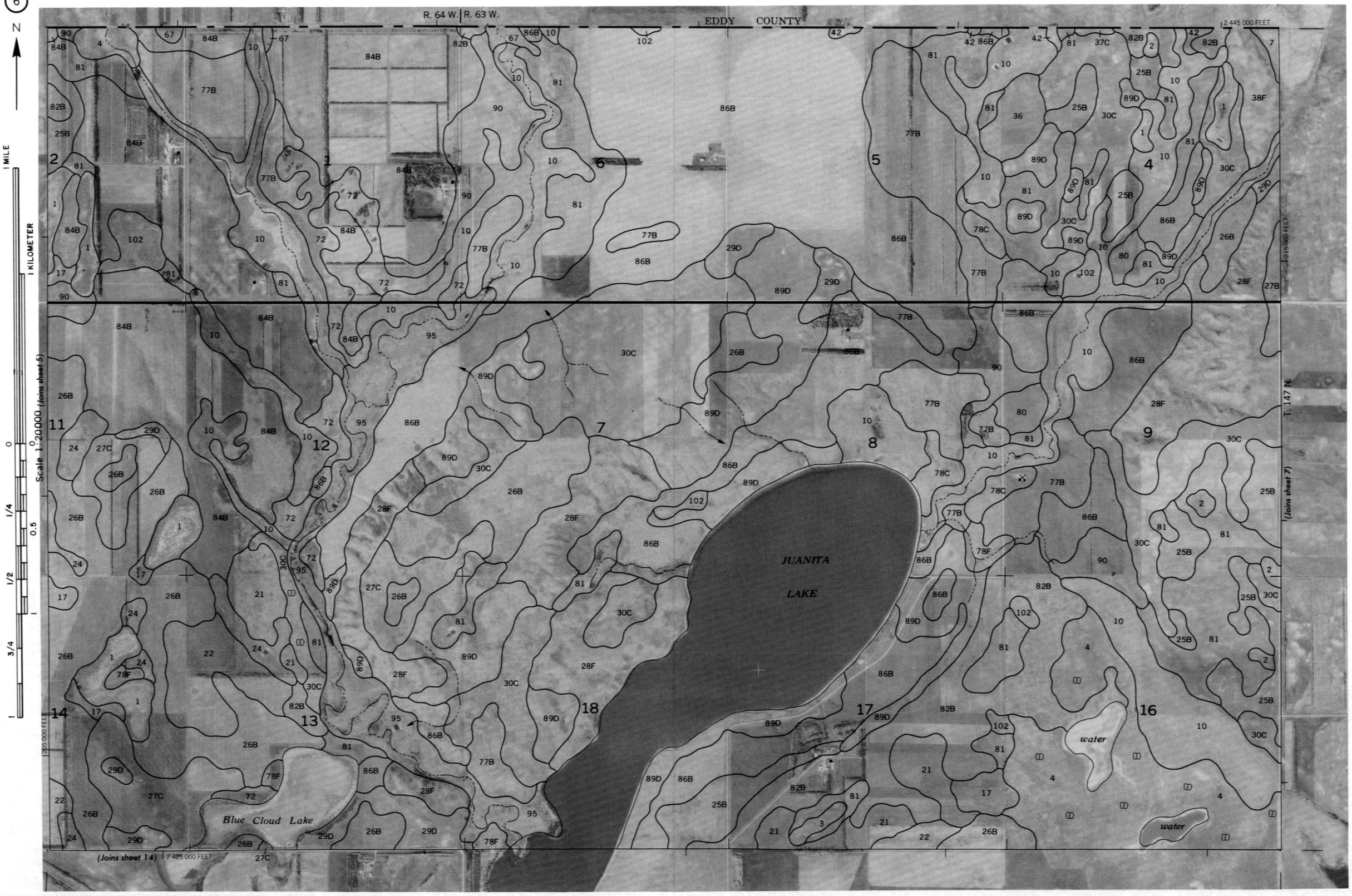


SOIL MAP OF FOSTER COUNTY, NORTH DAKOTA – SHEET NUMBER 4



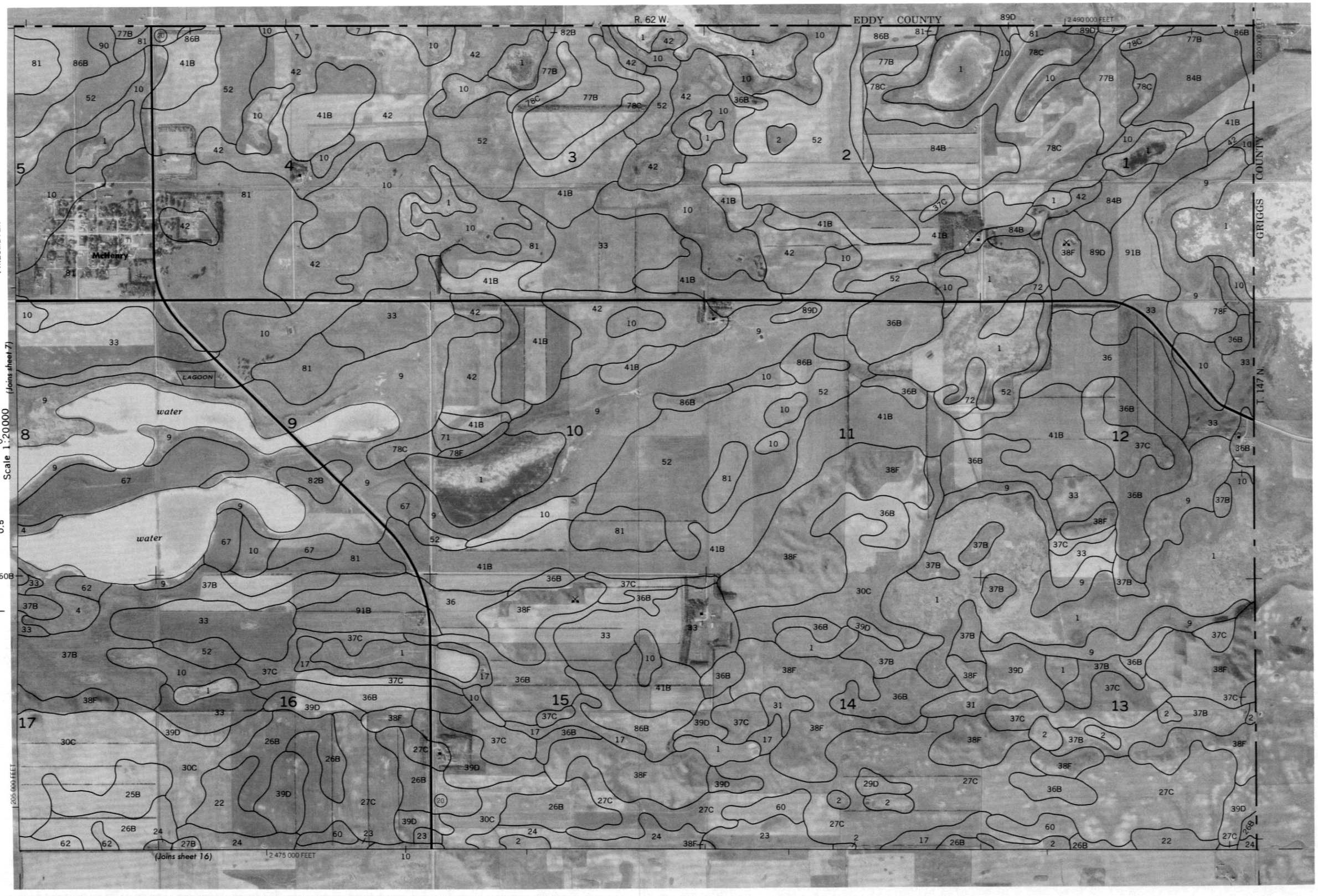
SOIL MAP OF FOSTER COUNTY, NORTH DAKOTA - SHEET NUMBER 5

SOIL MAP OF FOSTER COUNTY, NORTH DAKOTA – SHEET NUMBER 6



SOIL MAP OF FOSTER COUNTY, NORTH DAKOTA – SHEET NUMBER 7

SOIL MAP OF FOSTER COUNTY, NORTH DAKOTA – SHEET NUMBER 8



SOIL MAP OF FOSTER COUNTY, NORTH DAKOTA - SHEET NUMBER 9

9

N

R. 67 W.

(Joins sheet 1)

2 305 000 FEET

200 000 FEET

T. 147 N.

WELLS COUNTY

Scotts Slough

SOO LINE

(Joins sheet 10)

(Joins sheet 17)

2 325 000 FEET

190 000 FEET

1 MILE

1 KILOMETER

Scale 1:20000

10

N

1 MILE

1 KILOMETER

0

Scale 1:20000

0 0.5 1/4 1/2 3/4

2 350 000 FEET

200 000 FEET

190 000 FEET

2 330 000 FEET

(Joins sheet 2)

(Joins sheet 9)

(Joins sheet 11)

(Joins sheet 18)

R. 67 W. | R. 66 W.

T. 147 N.

RED RIVER VALLEY AND WESTERN

water

CARRINGTON RESEARCH EXTENSION CENTER

Slough

Scotts Slough

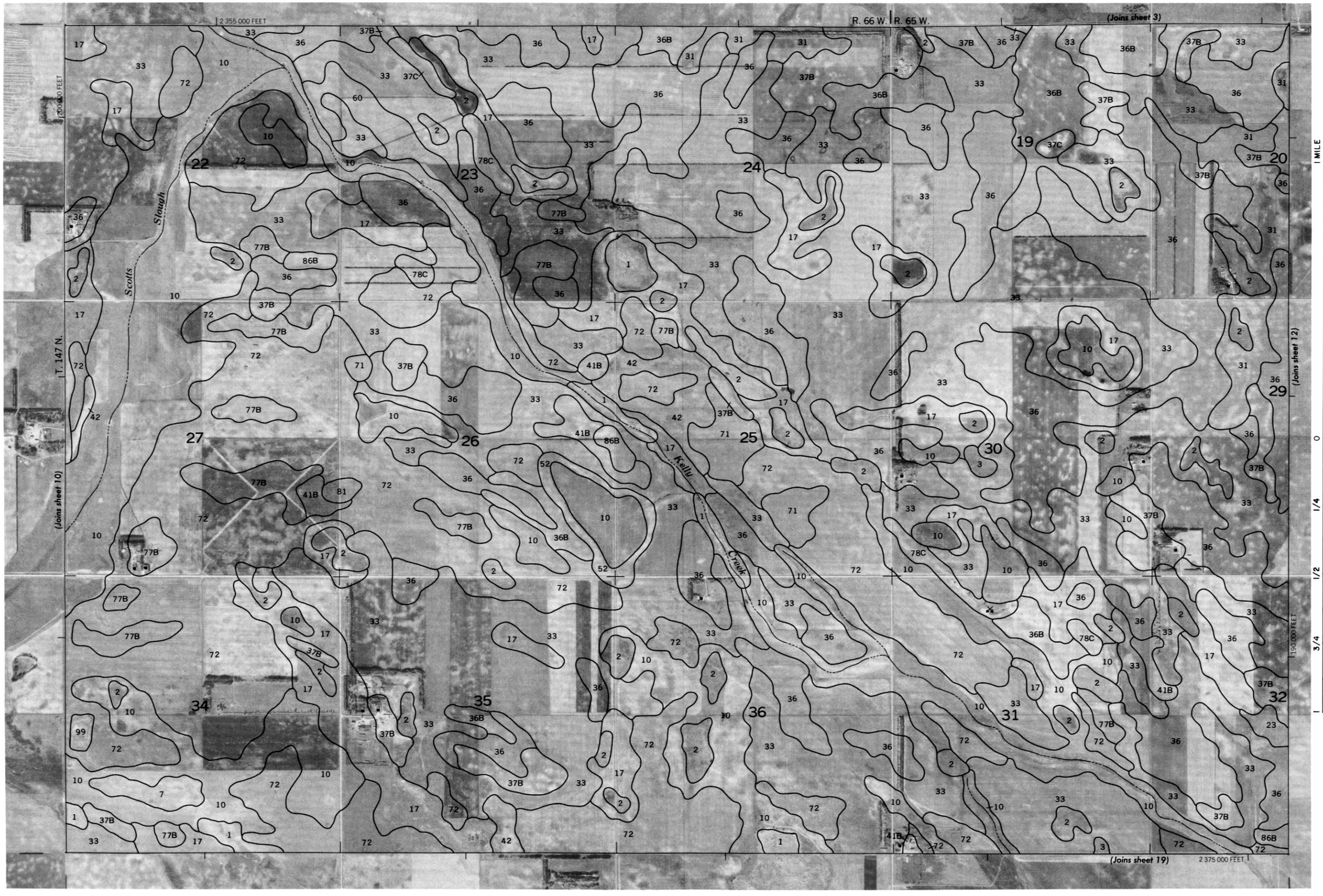
23 24 19 20 21

25 30 29 28

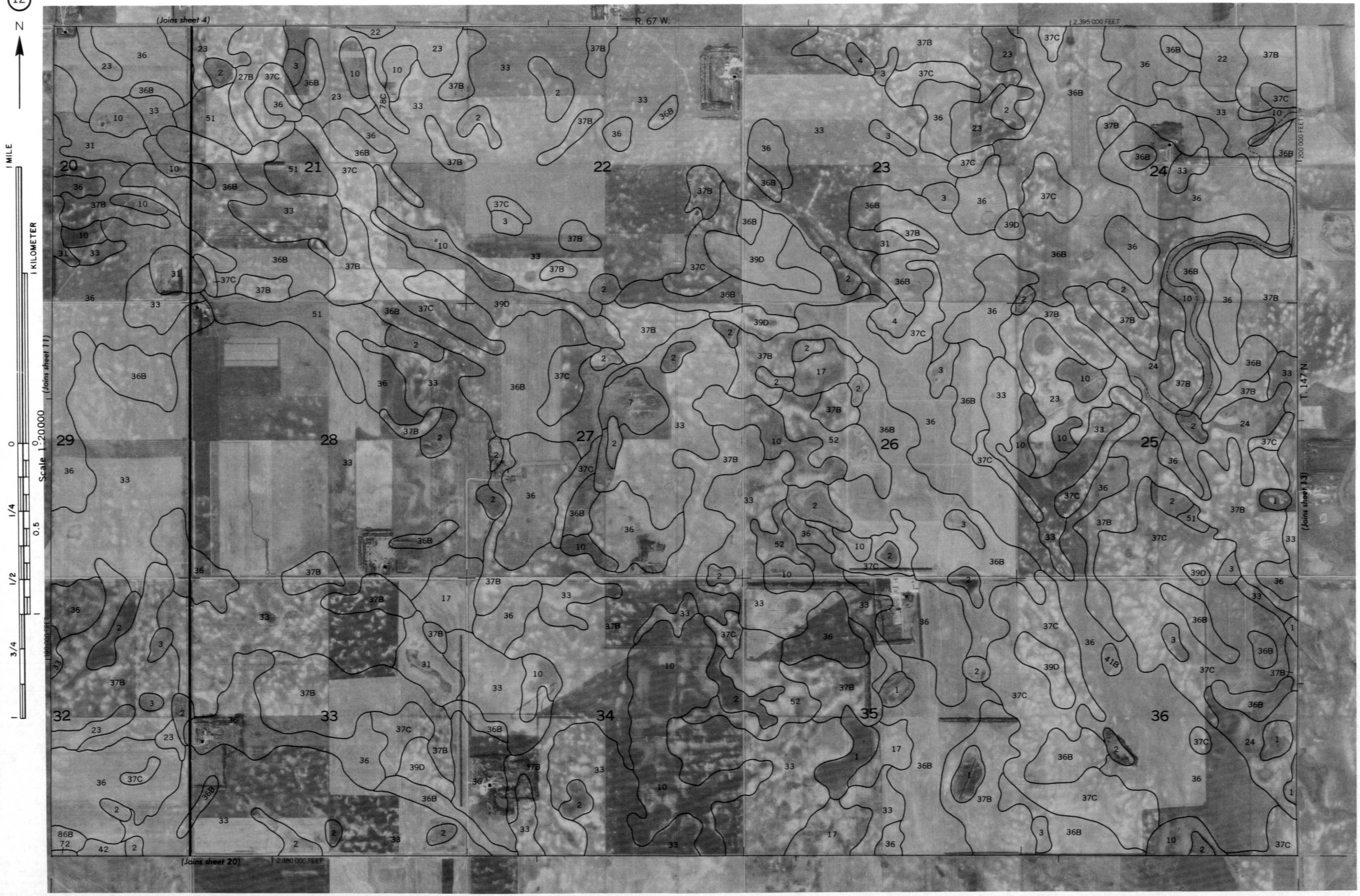
26 35 36 31 32 33

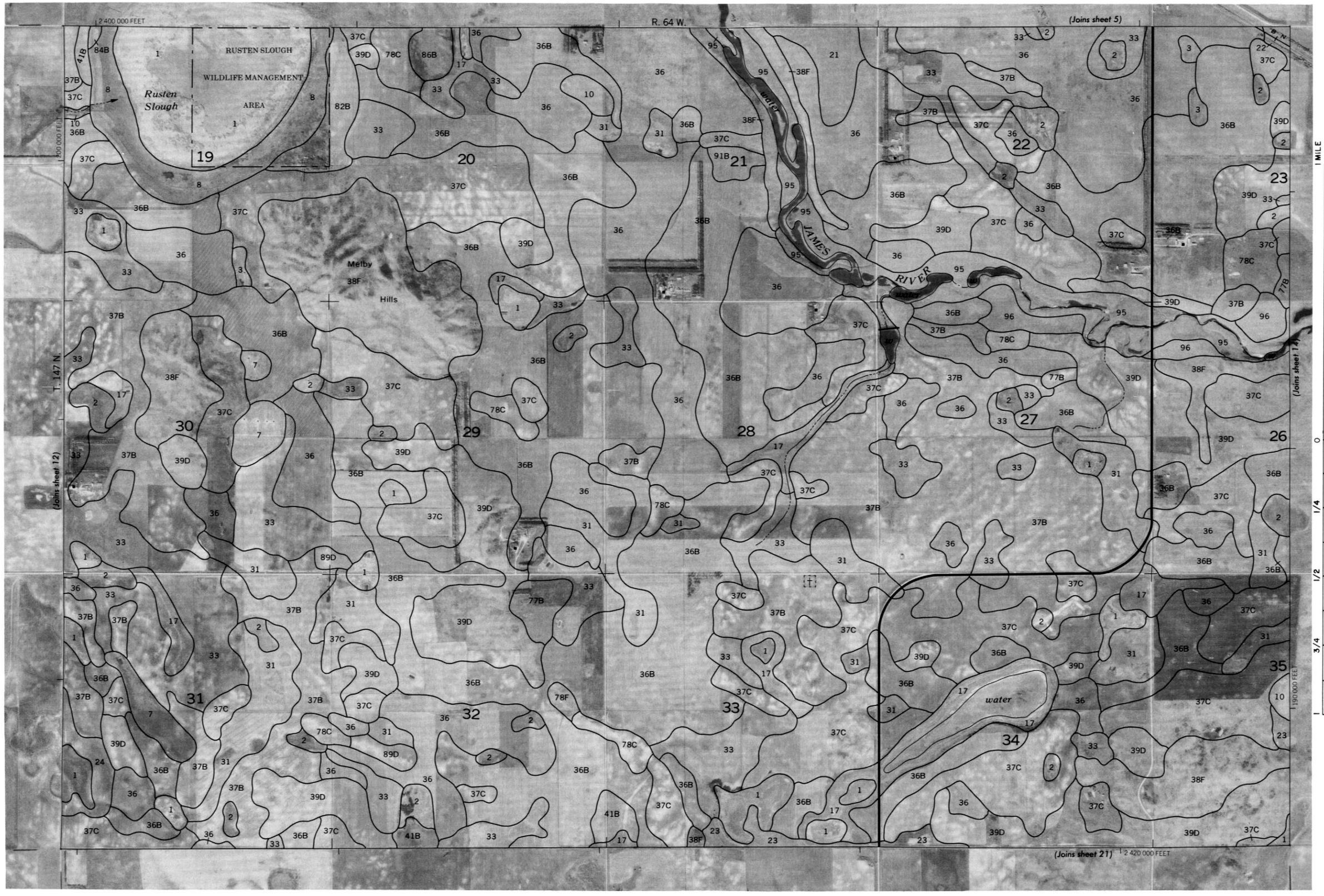
2 3 4 7 10 17 31 33 36 37B 37C 39D 42 51 60 61 62 72 77B 281

SOIL MAP OF FOSTER COUNTY, NORTH DAKOTA - SHEET NUMBER 11



SOIL MAP OF FOSTER COUNTY, NORTH DAKOTA – SHEET NUMBER 12




2 400 000 FEET
R. 64 W.
(Joins sheet 5)
RUSTEN SLOUGH
WILDLIFE MANAGEMENT
AREA
Rusten Slough
19
20
21
22
23
30
29
28
27
26
31
32
33
34
35
James River
water
Melby
Hills
T. 147 N.
200 000 FEET
(Joins sheet 12)
(Joins sheet 21)
2 420 000 FEET
190 000 FEET
(Joins sheet 14)
N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0.5


14
N
1 MILE
1 KILOMETER
Scale 1:20000
0
0.5
1
1/4
1/2
3/4
(Joins sheet 6)
R. 64 W.
R. 63 W.
Blue Cloud Lake
water
JUANITA LAKE
JAMES RIVER
RIVER
water
BURLINGTON NORTHERN
2 445 000 FEET
200 000 FEET
190 000 FEET
2 425 000 FEET
(Joins sheet 13)
(Joins sheet 22)
(Joins sheet 15)
T. 147 N.
19
20
21
23
24
25
26
28
29
30
31
32
33
35
36

SOIL MAP OF FOSTER COUNTY, NORTH DAKOTA – SHEET NUMBER 15

15

N

2 450 000 FEET

R. 63 W. | R. 62 W.

(Joins sheet 7)

200 000 FEET

T. 147 N.

(Joins sheet 14)

(Joins sheet 16)

(Joins sheet 23)

2 470 000 FEET

190 000 FEET

Stoney Lake

Bald Hill Creek

Juanita

BURLINGTON NORTHERN

water

1 MILE

1 KILOMETER

Scale 1:20000

0 0.5 1

1/4 1/2 3/4

Coordinate grid ticks and land division corners, if shown, are approximately positioned

SOIL MAP OF FOSTER COUNTY, NORTH DAKOTA – SHEET NUMBER 16

16

N

1 MILE

1 KILOMETER

Scale 1:20000

0 0.5 1

(Joins sheet 15)

(Joins sheet 8)

R. 62 W.

2 490 000 FEET

T. 147 N.

FOSTER COUNTY

GRIGGS COUNTY

Bald Hill Creek

Bald Hill Creek

water

water

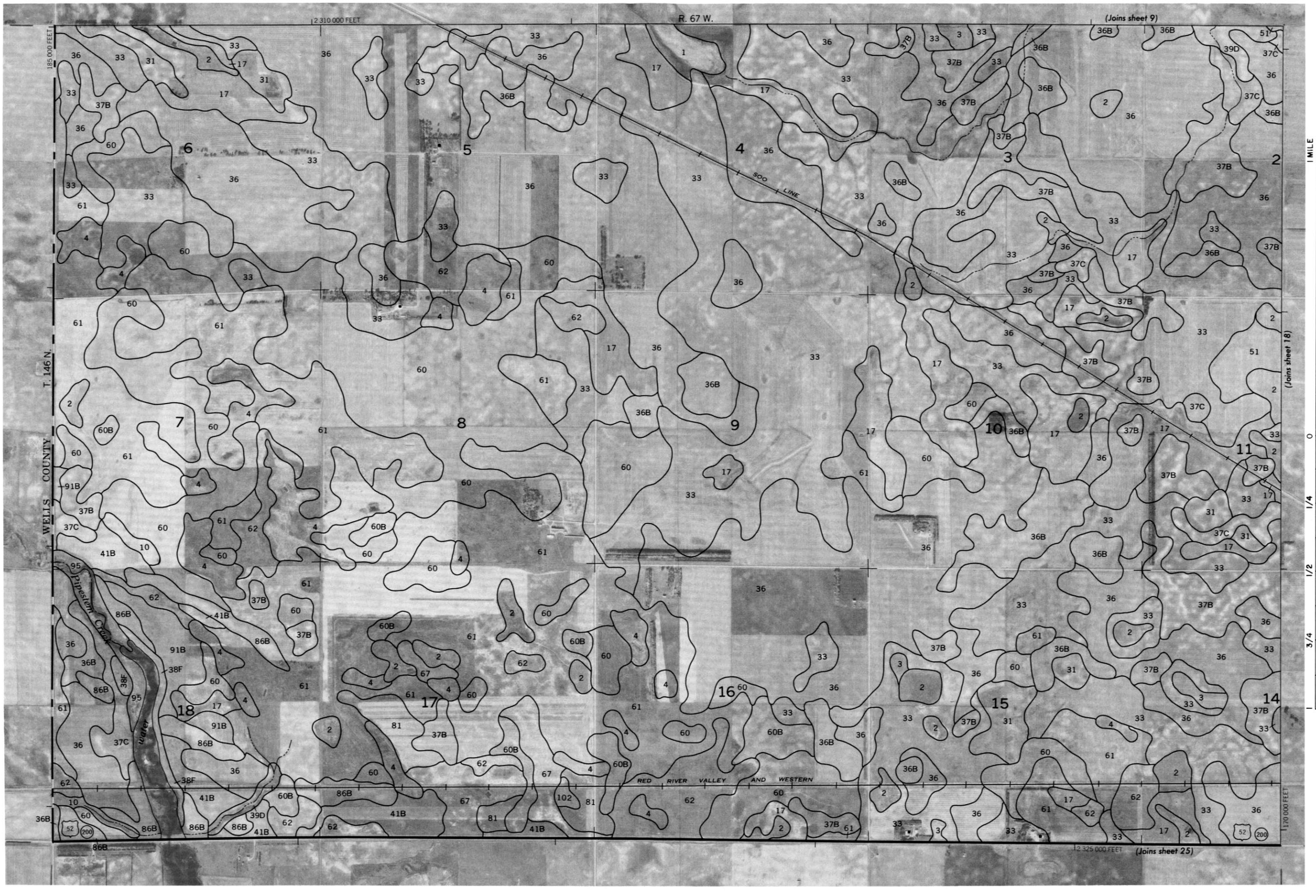
(Joins sheet 24)

2 475 000 FEET

190 000 FEET

This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.

SOIL MAP OF FOSTER COUNTY, NORTH DAKOTA – SHEET NUMBER 17



Coordinate grid ticks and land division corners, if shown, are approximately positioned

SOIL MAP OF FOSTER COUNTY, NORTH DAKOTA – SHEET NUMBER 18

18

N

(Joins sheet 10)

R. 67 W. | R. 66 W.

2 350 000 FEET

185 000 FEET

Scotts Slough

RED RIVER VALLEY AND WESTERN

SOO LINE

R.R. AND R.R.

CARRINGTON CEMETERY

LAGOON

CARRINGTON

T. 146 N.

(Joins sheet 17)

(Joins sheet 19)

(Joins sheet 26)

2 330 000 FEET

170 000 FEET

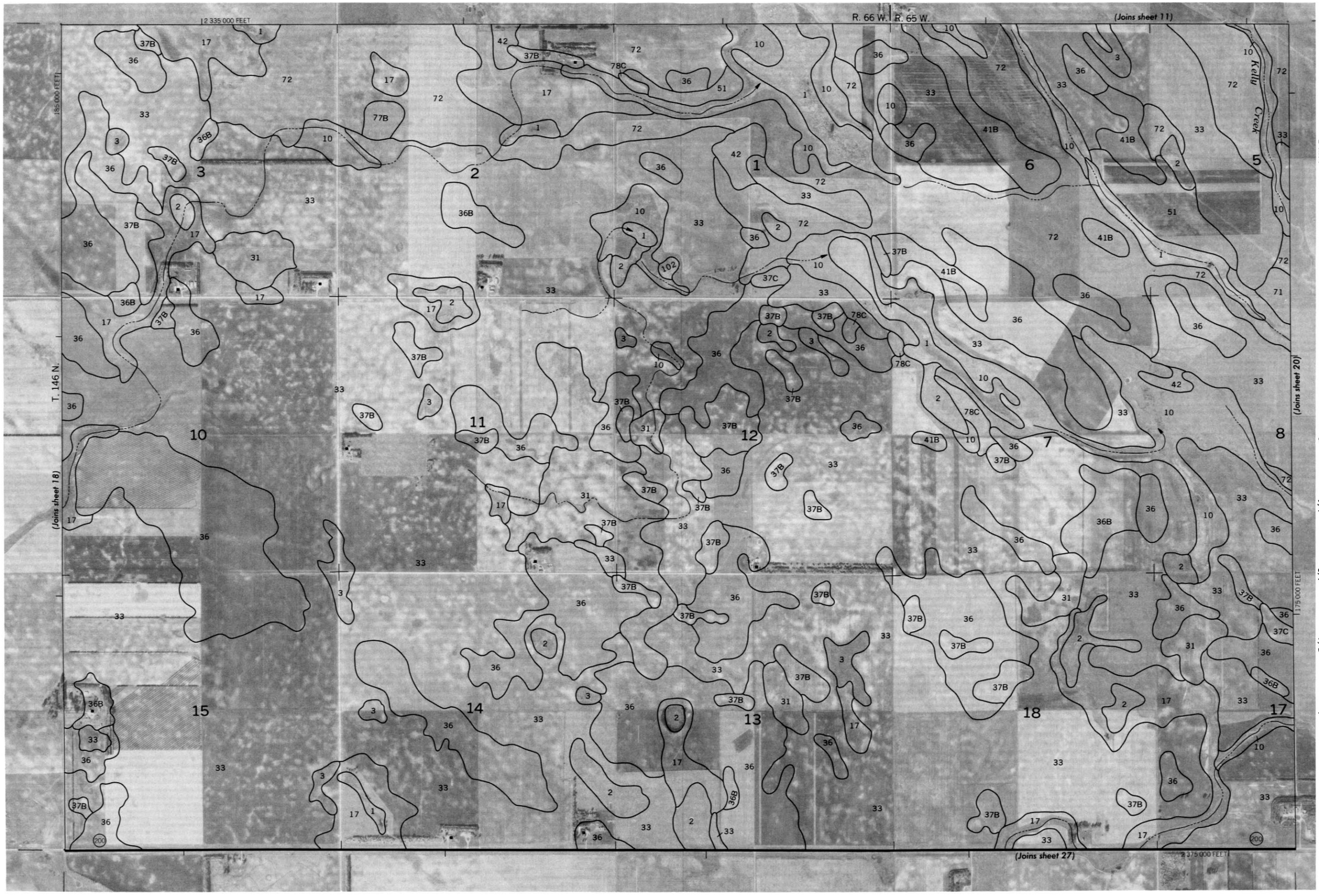
Scale 1:20000

1 MILE

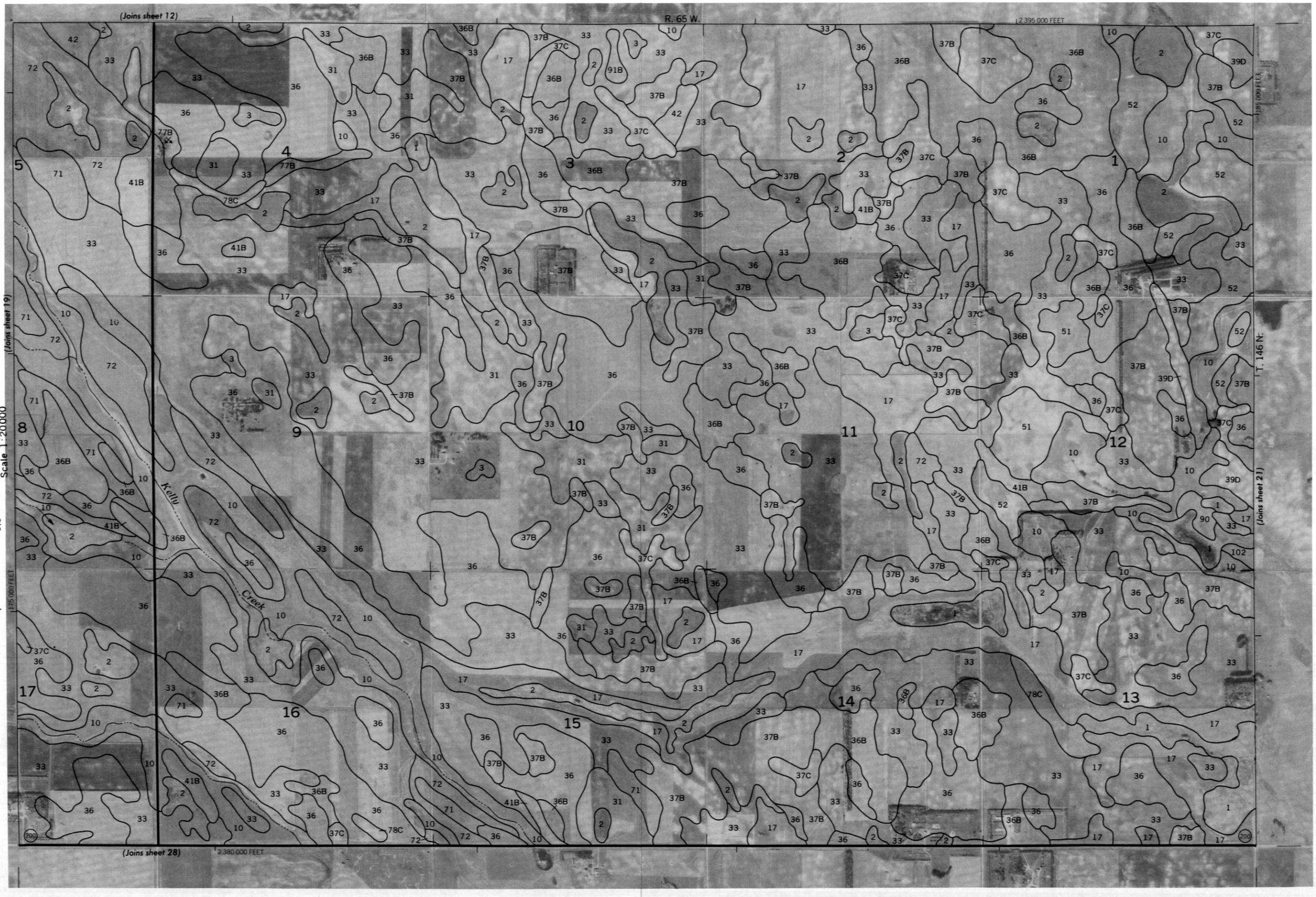
1 KILOMETER

0 1/4 1/2 3/4 0.5

SOIL MAP OF FOSTER COUNTY, NORTH DAKOTA – SHEET NUMBER 19

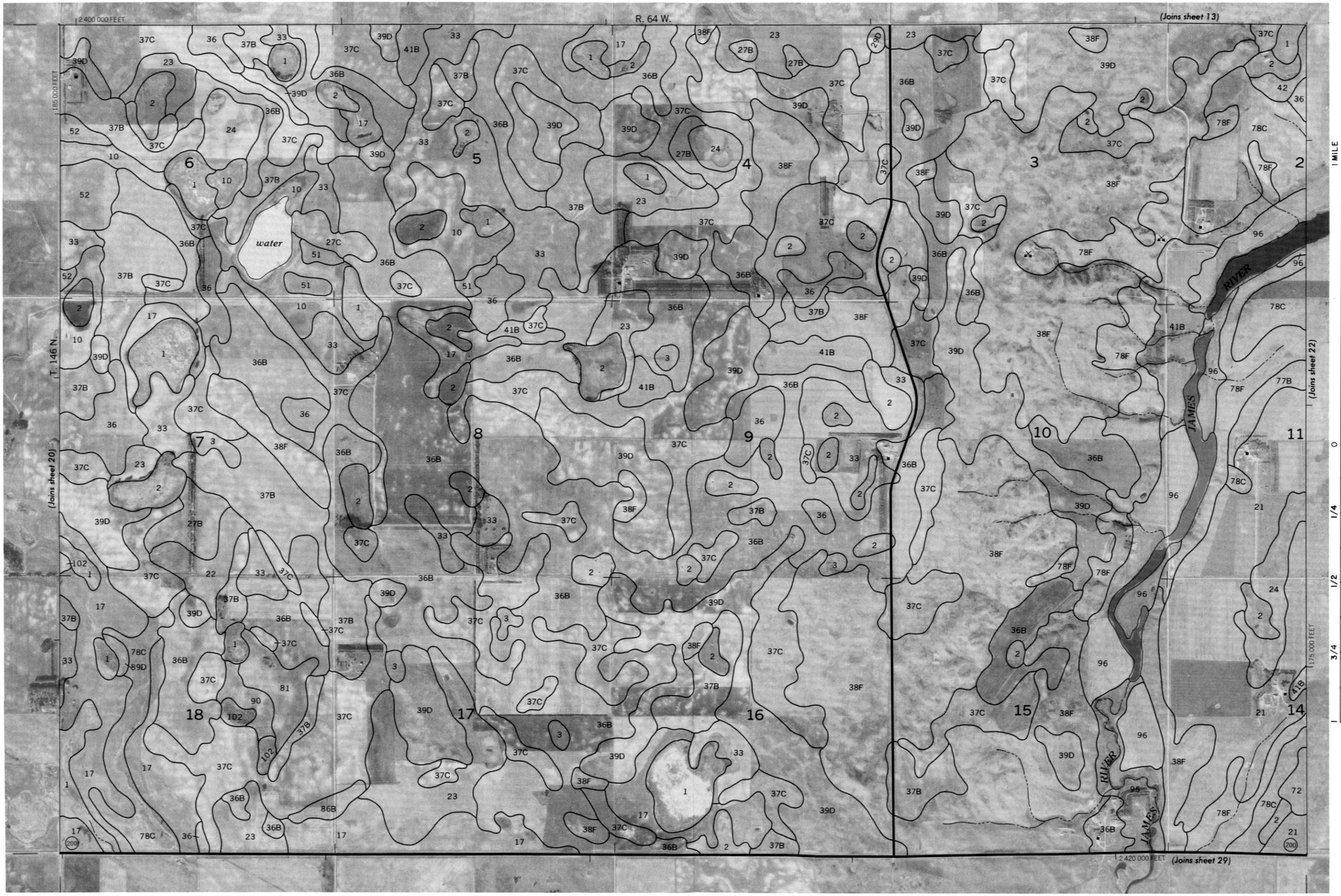


SOIL MAP OF FOSTER COUNTY, NORTH DAKOTA – SHEET NUMBER 20



This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture. Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

SOIL MAP OF FOSTER COUNTY, NORTH DAKOTA – SHEET NUMBER 21



Coordinate grid ticks and land division corners, if shown, are approximately positioned

SOIL MAP OF FOSTER COUNTY, NORTH DAKOTA – SHEET NUMBER 22

22

N

(Joins sheet 14) | R. 64 W. | R. 63 W.

2 445 000 FEET

185 000 FEET

T. 146 N.

(Joins sheet 23)

1 MILE

1 KILOMETER

Scale 1:20000

(Joins sheet 21)

175 000 FEET

2 425 000 FEET

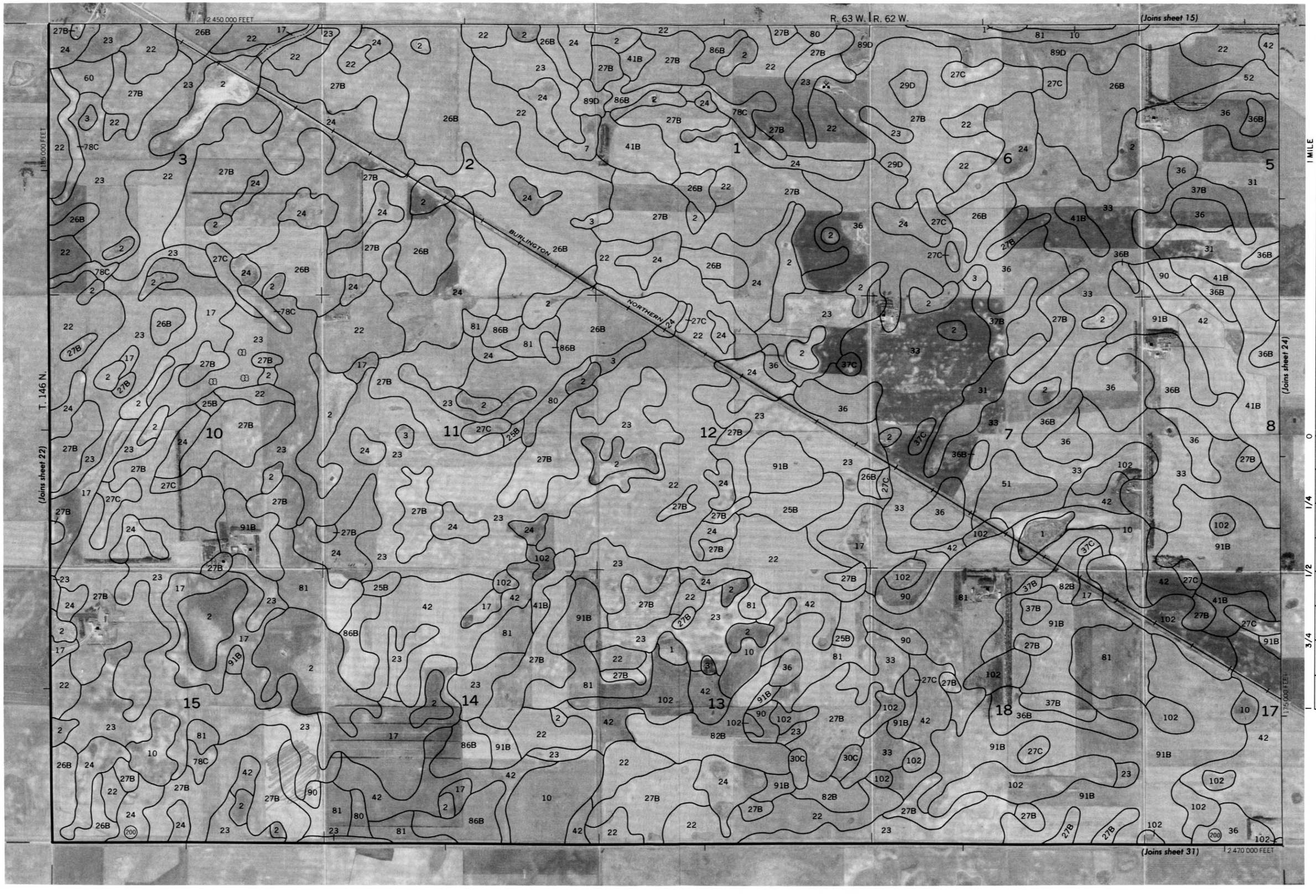
(Joins sheet 30)

JAMES RIVER

water

This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture. Soil Conservation Service and cooperating agencies.

SOIL MAP OF FOSTER COUNTY, NORTH DAKOTA – SHEET NUMBER 23



Coordinate grid ticks and land division corners, if shown, are approximately positioned

SOIL MAP OF FOSTER COUNTY, NORTH DAKOTA – SHEET NUMBER 24

24

N

(Joins sheet 16)

R. 62 W.

2 490 000 FEET

1 MILE

1 KILOMETER

(Joins sheet 23)

Scale 1:20000

0 1/4 0.5 1/2 3/4 1

1 000 FEET

T. 146 N.

GRIGGS COUNTY

BURLINGTON NORTHERN

(Joins sheet 32)

2 475 000 FEET

This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.

SOIL MAP OF FOSTER COUNTY, NORTH DAKOTA – SHEET NUMBER 25

25

N

1 MILE

1 KILOMETER

Scale 1:20000

0 0.5 1

1/4 1/2 3/4

(Joins sheet 17)

2 310 000 FEET

R. 67 W.

T. 146 N.

WELLS COUNTY

165 000 FEET

(Joins sheet 26)

155 000 FEET

(Joins sheet 33)

2 325 000 FEET

Pipestem Creek

water

19 20 21 22 23

30 29 28 27 26

31 32 33 34 35

Coordinate grid ticks and land division corners, if shown, are approximately positioned

SOIL MAP OF FOSTER COUNTY, NORTH DAKOTA – SHEET NUMBER 26

26

N

(Joins sheet 18) R. 67 W. | R. 66 W.

2 350 000 FEET

170 000 FEET

CARRINGTON AIRPORT

CARRINGTON

SOO LINE

RED RIVER VALLEY AND WESTERN

T. 146 N.

(Joins sheet 27)

(Joins sheet 25)

155 000 FEET

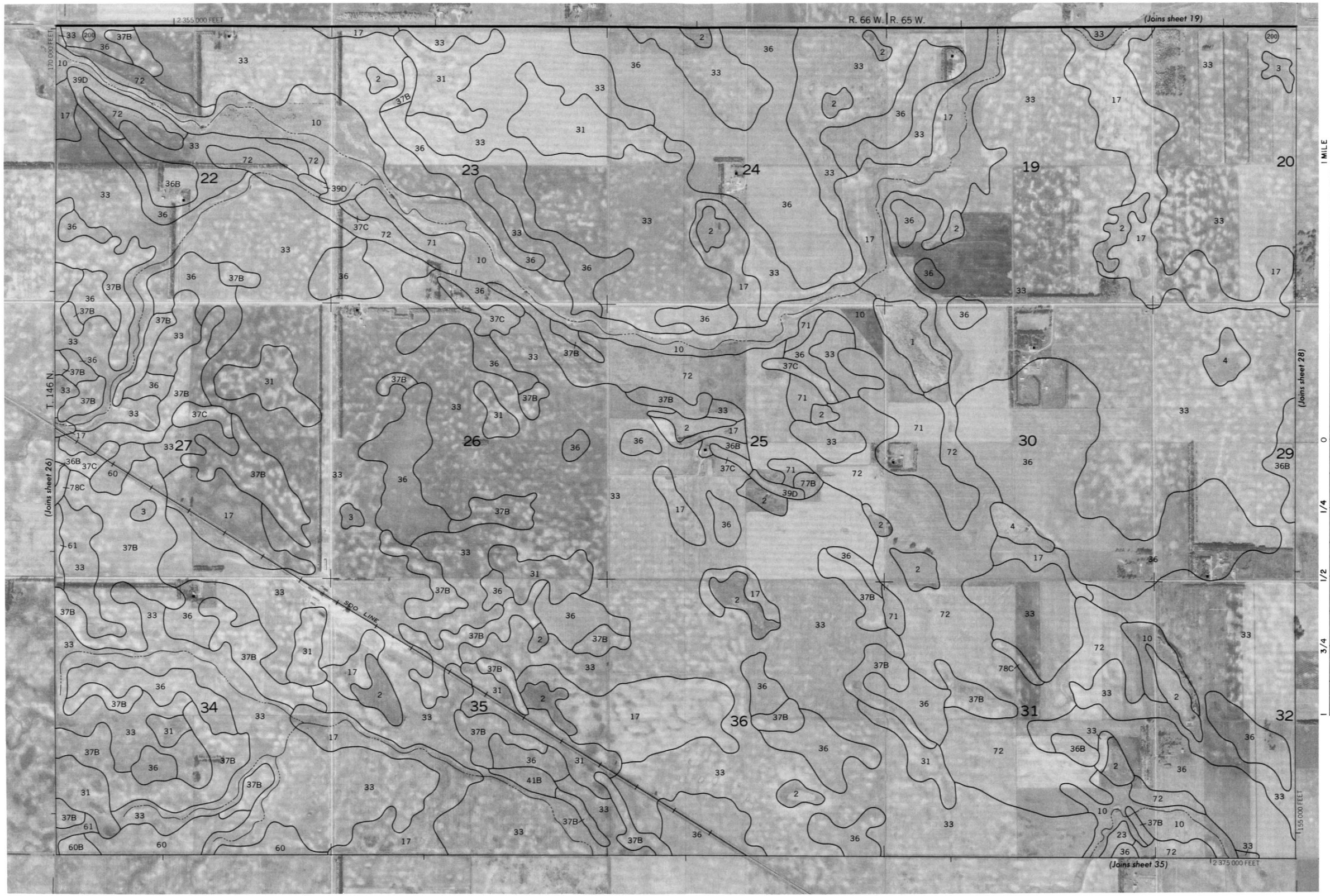
2 330 000 FEET (Joins sheet 34)

Scale 1:20000

0 0.5 1 KILOMETER

0 1/4 1/2 3/4 1 MILE

SOIL MAP OF FOSTER COUNTY, NORTH DAKOTA - SHEET NUMBER 27



27

N

1 MILE

1 KILOMETER

0 0

Scale 1:20000

1/4 0.5 1/2 3/4

SOIL MAP OF FOSTER COUNTY, NORTH DAKOTA – SHEET NUMBER 28

28

N

(Joins sheet 20)

R. 65 W.

2 395 000 FEET

170 000 FEET

T. 146 N.

(Joins sheet 29)

1 MILE

1 KILOMETER

Scale 1:20000

(Joins sheet 27)

155 000 FEET

(Joins sheet 36)

2 380 000 FEET

Kelly Creek

SOIL MAP OF FOSTER COUNTY, NORTH DAKOTA - SHEET NUMBER 29

29

N

Scale 1:20000

1 MILE

1 KILOMETER

0 0 0.5 1

1/4 1/2 3/4 1

2 400 000 FEET

160 000 FEET

R. 64 W.

(Joins sheet 21)

(Joins sheet 28)

(Joins sheet 30)

(Joins sheet 37)

T. 146 N.

BRETHREN CEMETERY

Kelly Creek

JAMES RIVER

Jack Lake

SOIL MAP OF FOSTER COUNTY, NORTH DAKOTA – SHEET NUMBER 30

30

N

(Joins sheet 22)

R. 64 W. | R. 63 W.

2 445 000 FEET

James River Church

T. 146 N.

170 000 FEET

(Joins sheet 31)

1 MILE

1 KILOMETER

(Joins sheet 29)

Scale 1:20000

0 0.5 1

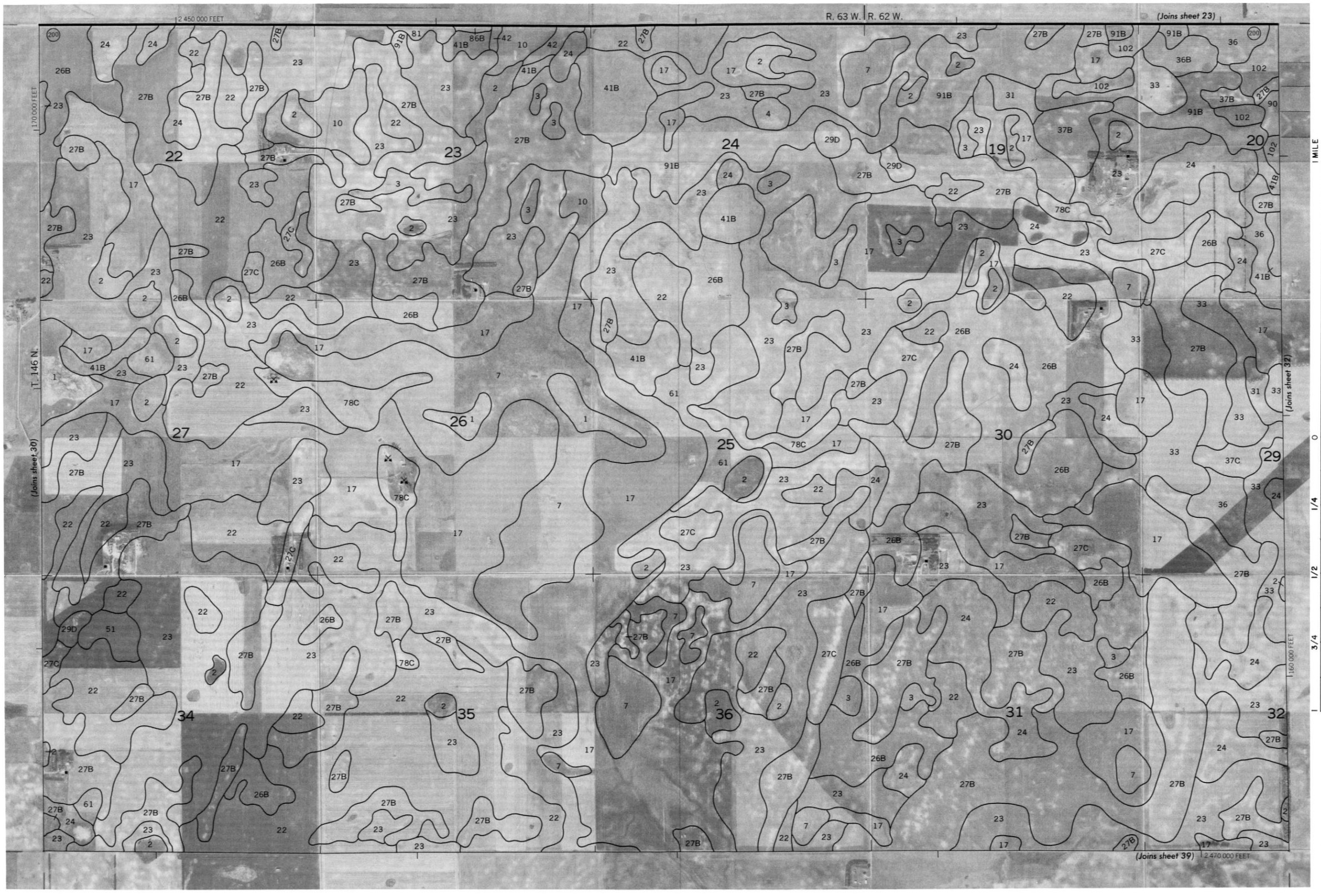
1/4 1/2 3/4

1660 000 FEET

2 425 000 FEET

(Joins sheet 38)

SOIL MAP OF FOSTER COUNTY, NORTH DAKOTA - SHEET NUMBER 31



SOIL MAP OF FOSTER COUNTY, NORTH DAKOTA – SHEET NUMBER 32

32

N

(Joins sheet 24)

R. 62 W.

2 490 000 FEET

Glenfield

LAGOON

GLENFIELD CEMETERY

BURLINGTON NORTHERN

20 21 22 23 24

29 28 27 26 25

32 33 34 35 36

T. 146 N.

170 000 FEET

GRIGGS COUNTY

1 MILE

1 KILOMETER

0

Scale 1:20000

1/4 0.5 1/2 1 3/4

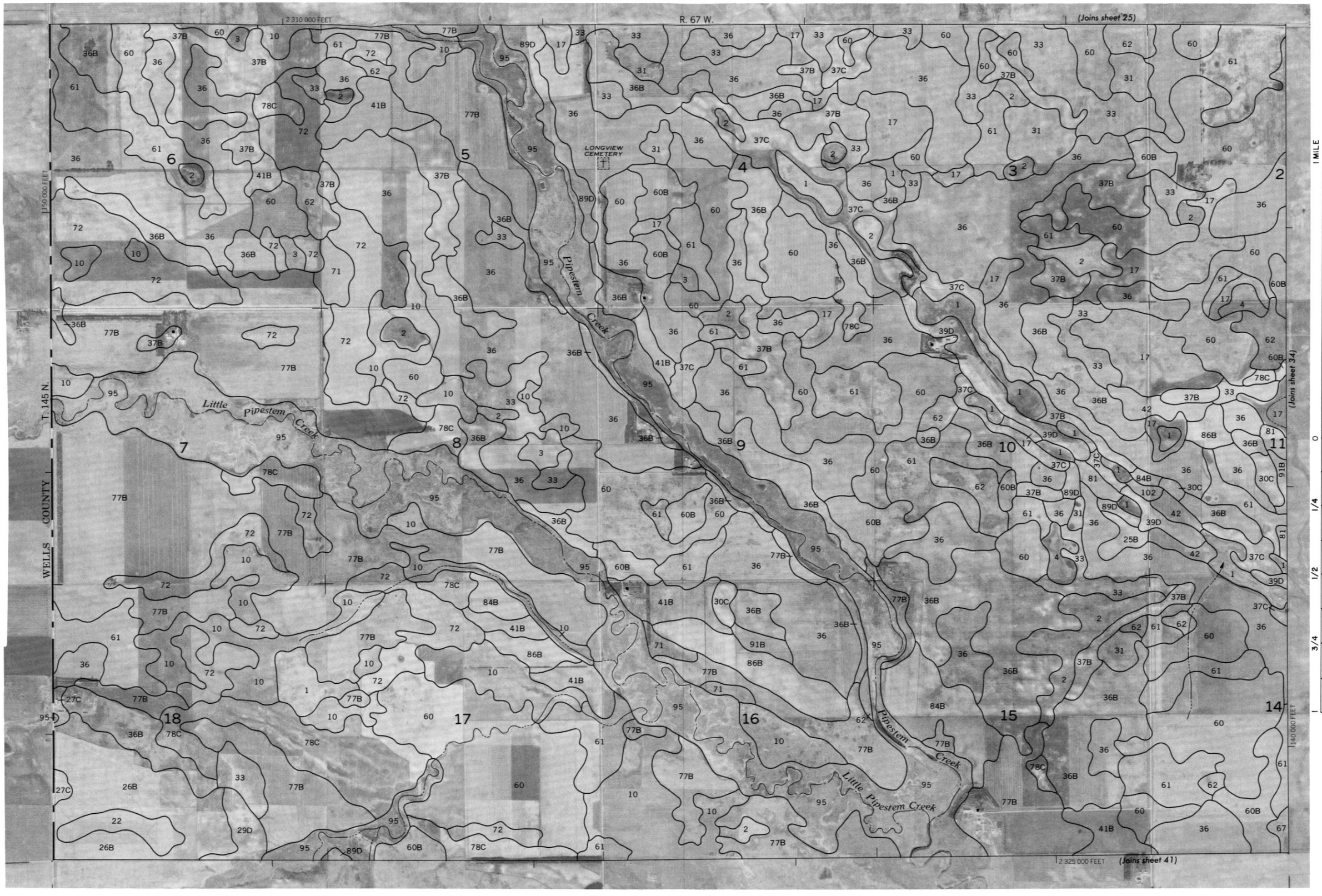
160 000 FEET

(Joins sheet 31)

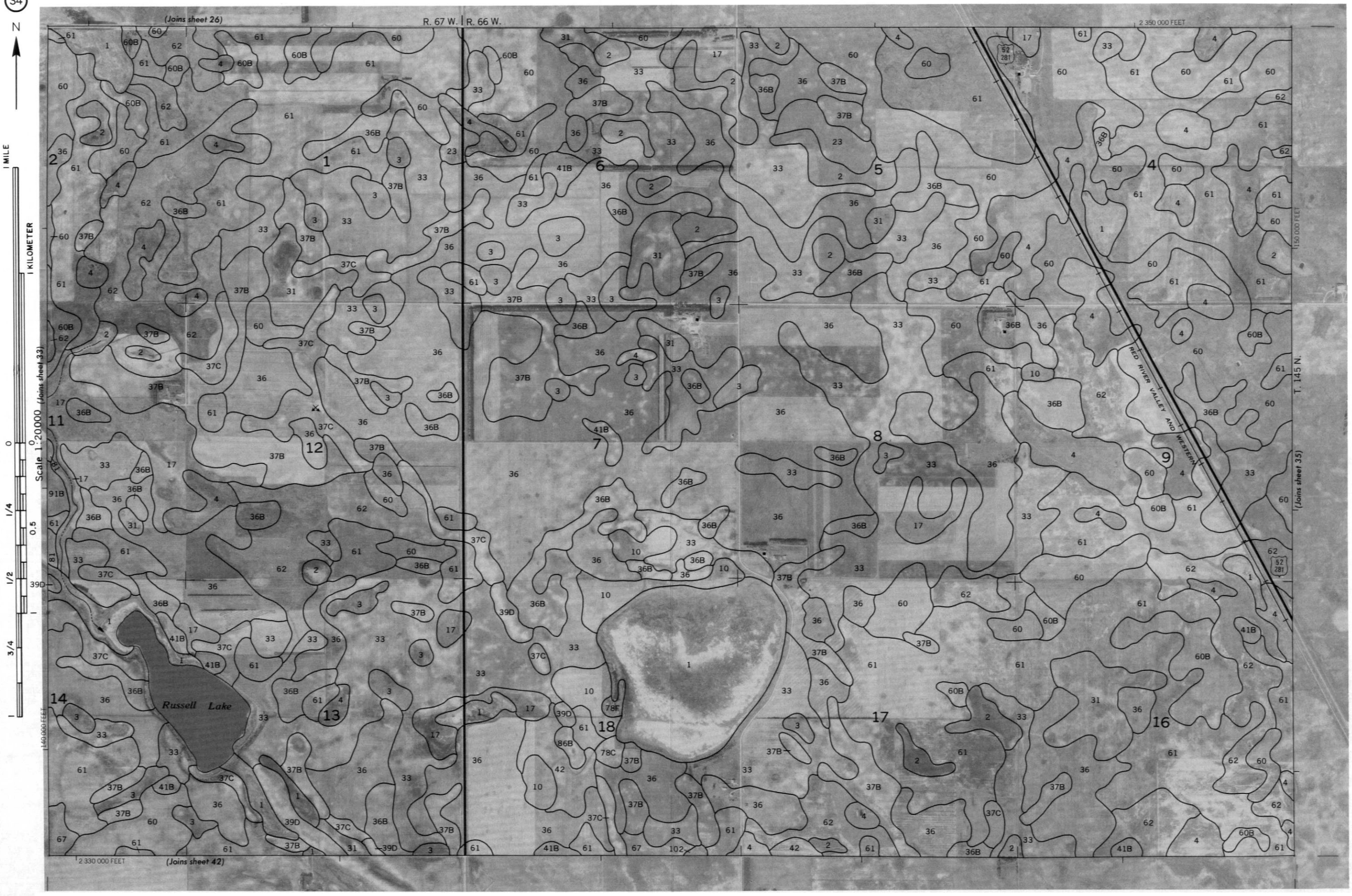
(Joins sheet 40)

2 475 000 FEET

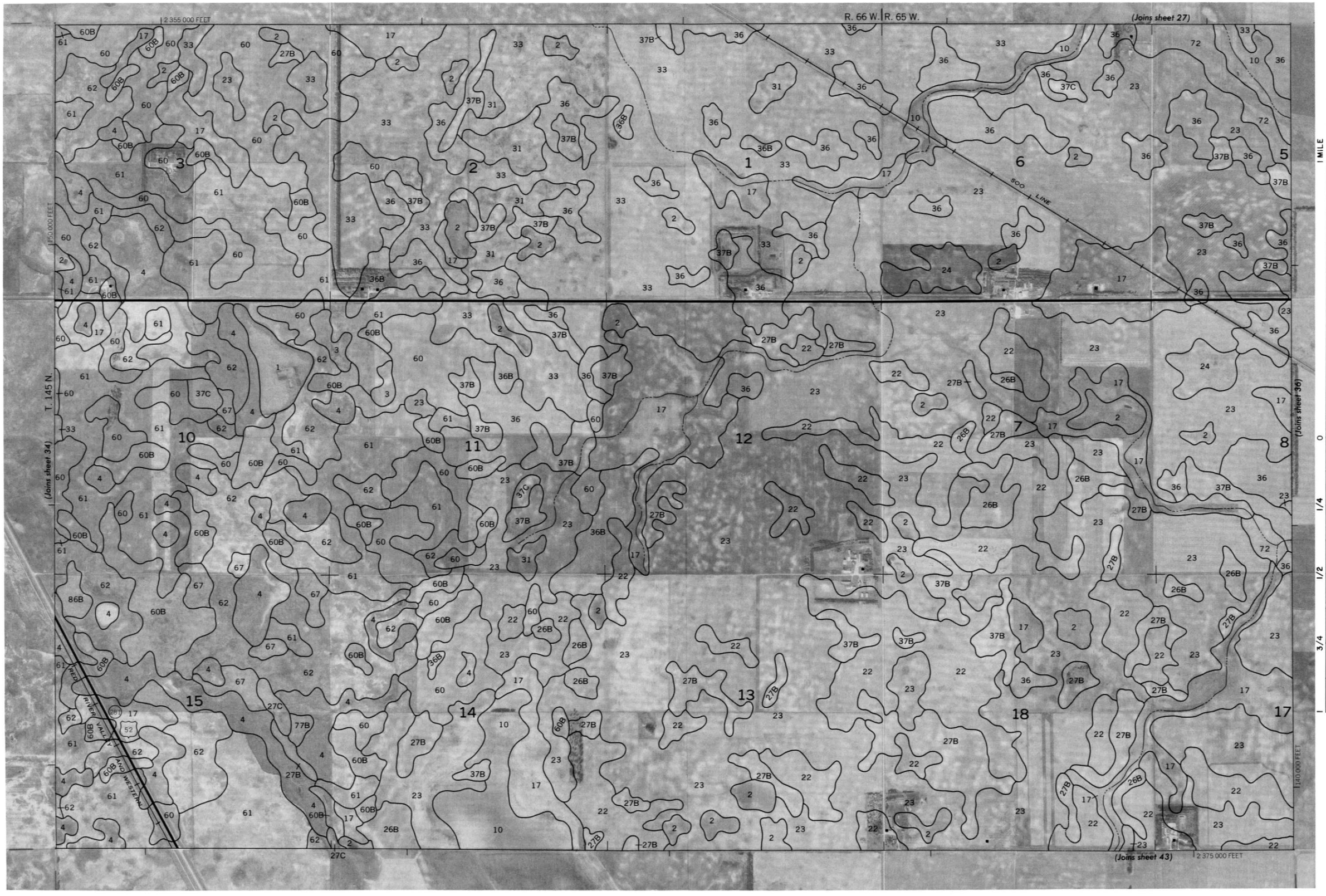
SOIL MAP OF FOSTER COUNTY, NORTH DAKOTA – SHEET NUMBER 33



SOIL MAP OF FOSTER COUNTY, NORTH DAKOTA – SHEET NUMBER 34



SOIL MAP OF FOSTER COUNTY, NORTH DAKOTA – SHEET NUMBER 35



SOIL MAP OF FOSTER COUNTY, NORTH DAKOTA – SHEET NUMBER 36

SOIL MAP OF FOSTER COUNTY, NORTH DAKOTA - SHEET NUMBER 37

37

N

2 405 000 FEET

R. 64 W.

(Joins sheet 29)

Jack Lake

Nieum Reservoir

JAMES RIVER

Kelly Creek

water

DRY LAKE

T. 145 N.

(Joins sheet 36)

(Joins sheet 38)

(Joins sheet 45)

155 000 FEET

2 420 000 FEET

140 000 FEET

1 MILE

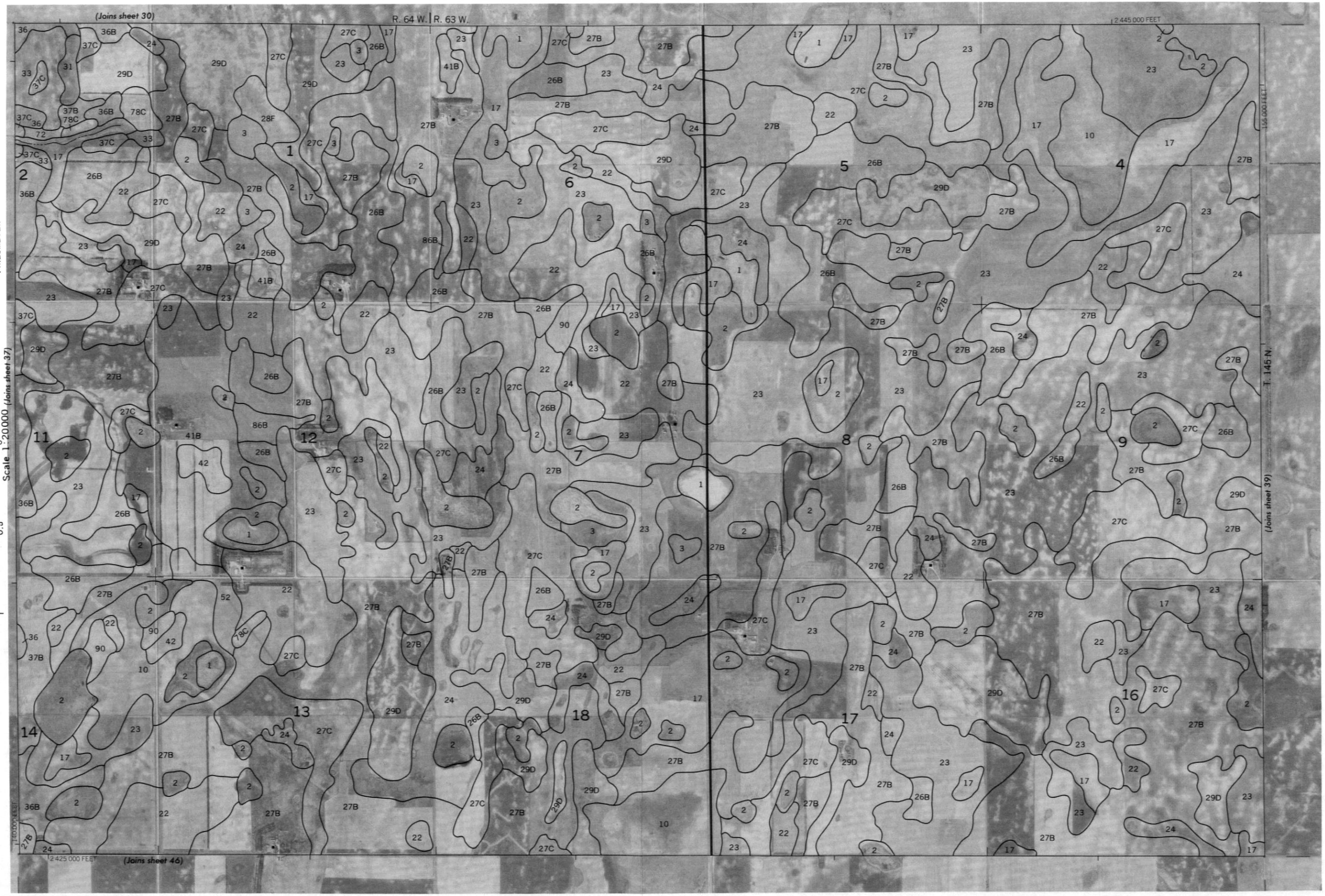
1 KILOMETER

Scale 1:20000

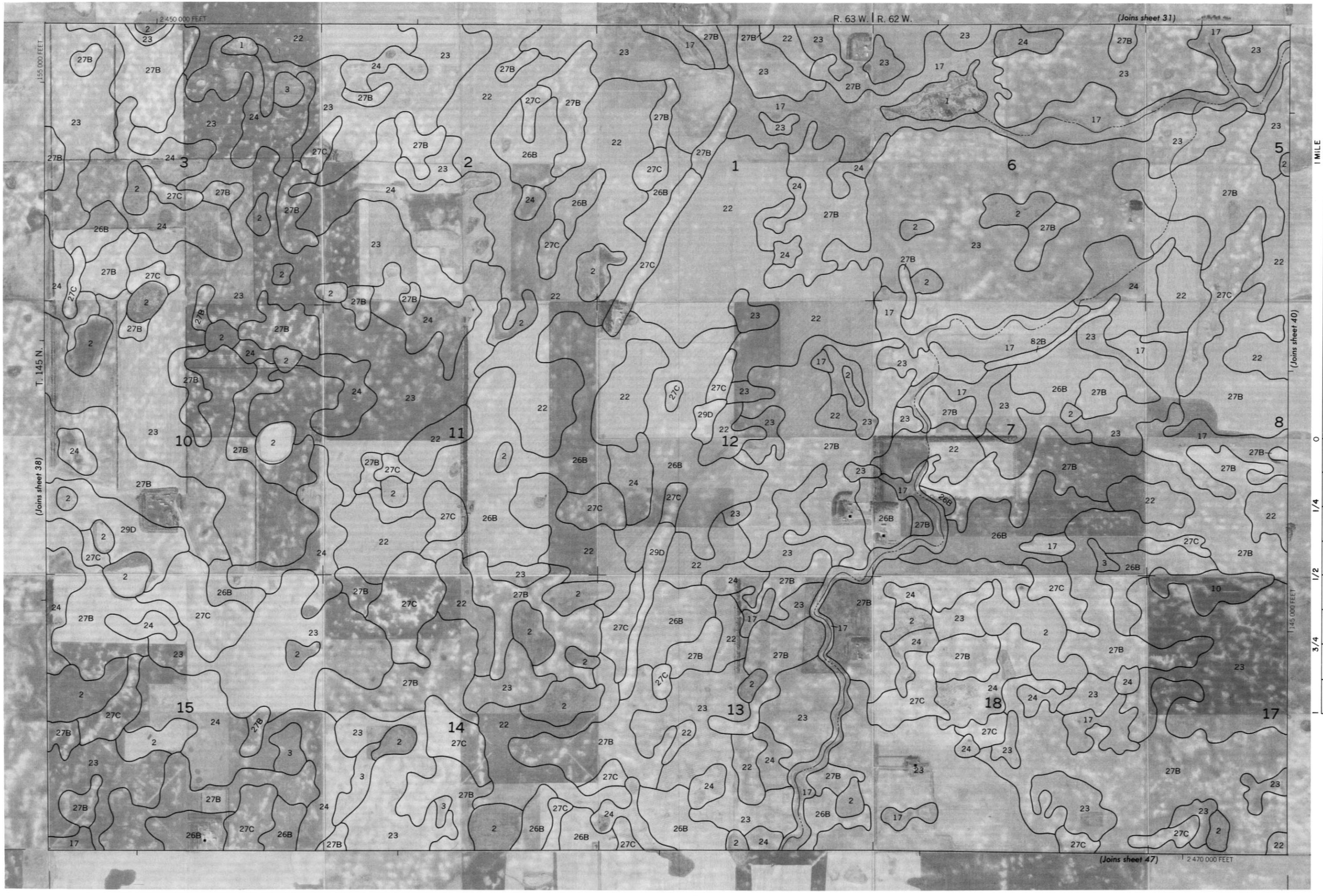
0 0.5 1

1/4 1/2 3/4 1

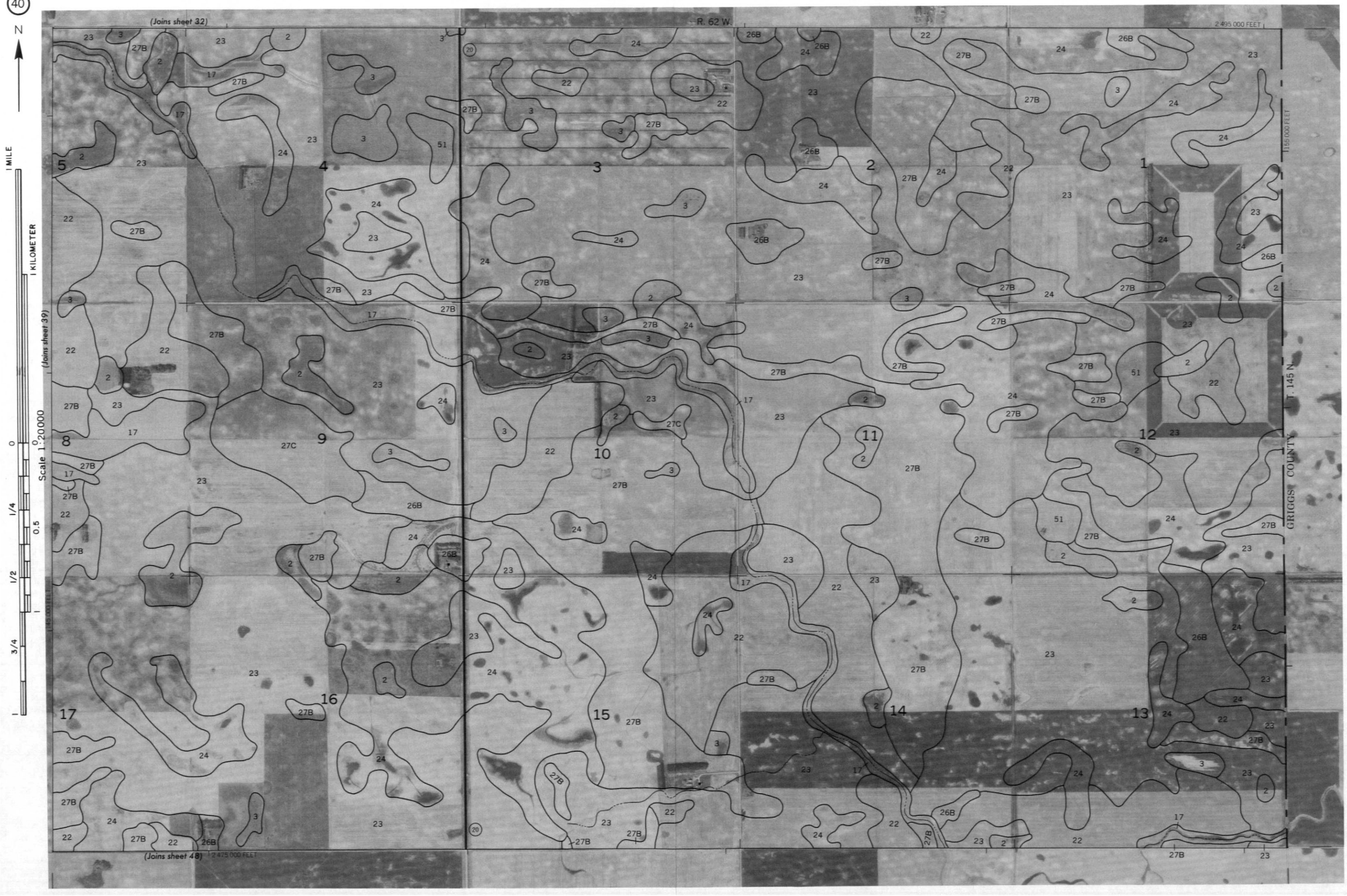
SOIL MAP OF FOSTER COUNTY, NORTH DAKOTA – SHEET NUMBER 38



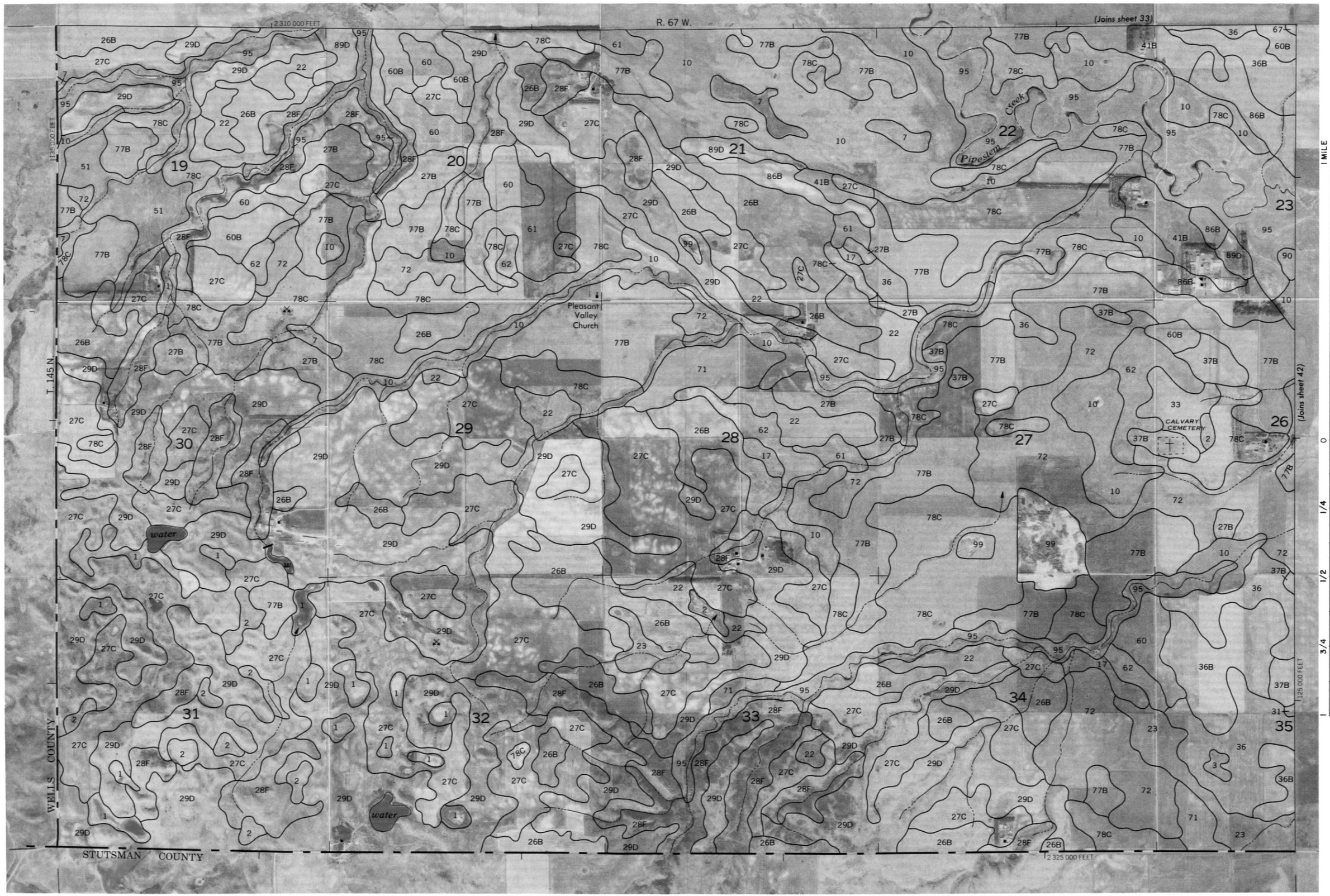
SOIL MAP OF FOSTER COUNTY, NORTH DAKOTA – SHEET NUMBER 39



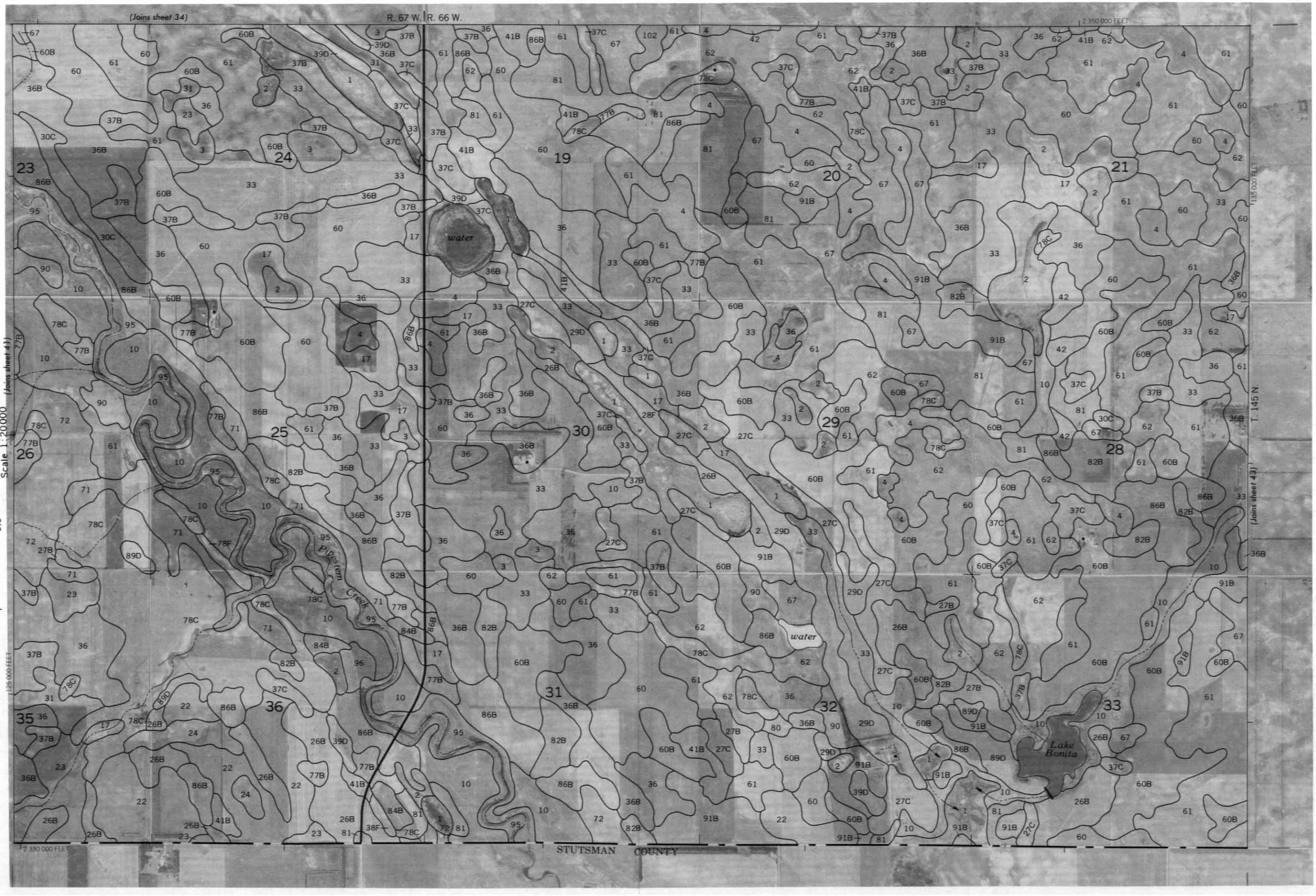
SOIL MAP OF FOSTER COUNTY, NORTH DAKOTA – SHEET NUMBER 40



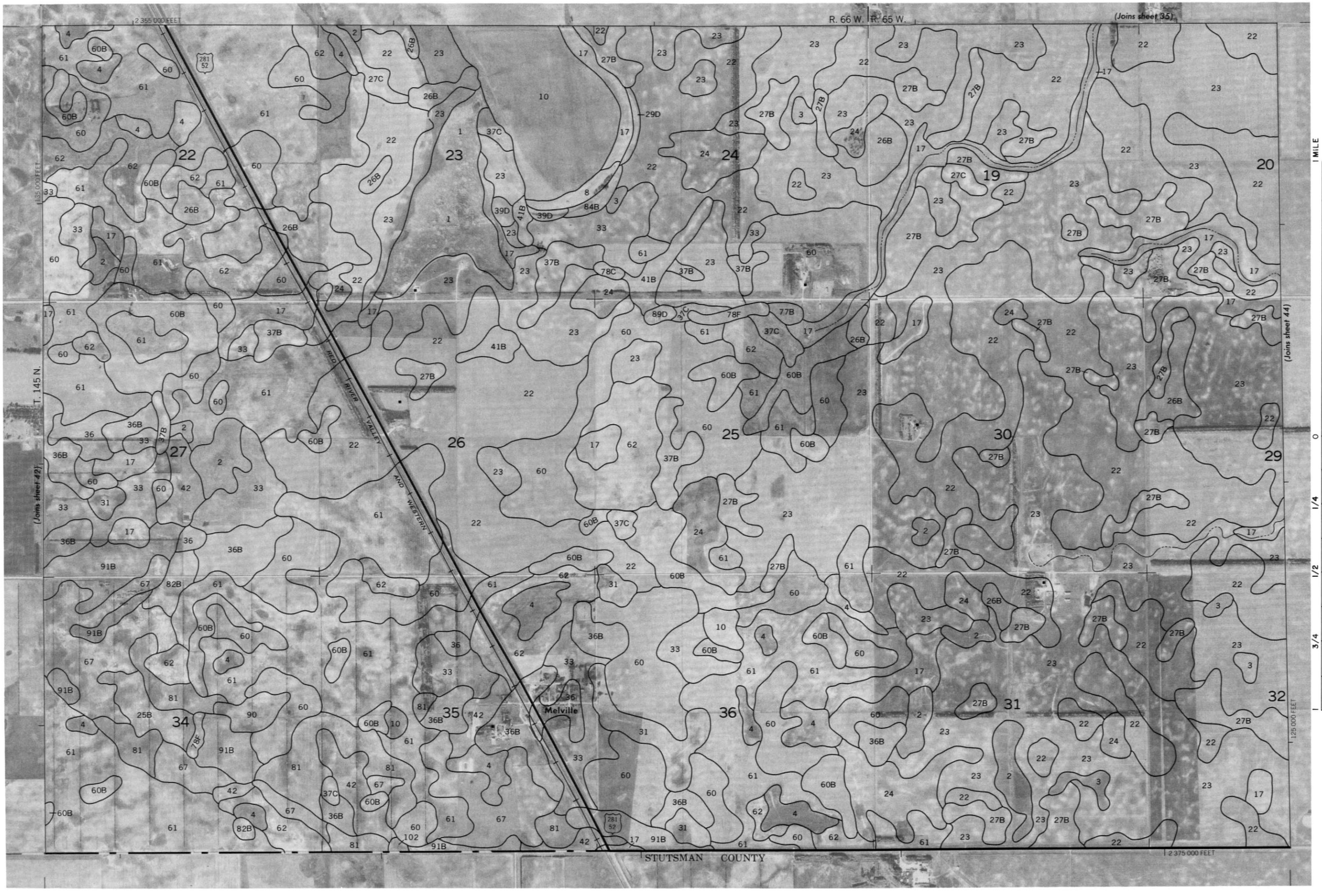
SOIL MAP OF FOSTER COUNTY, NORTH DAKOTA – SHEET NUMBER 41



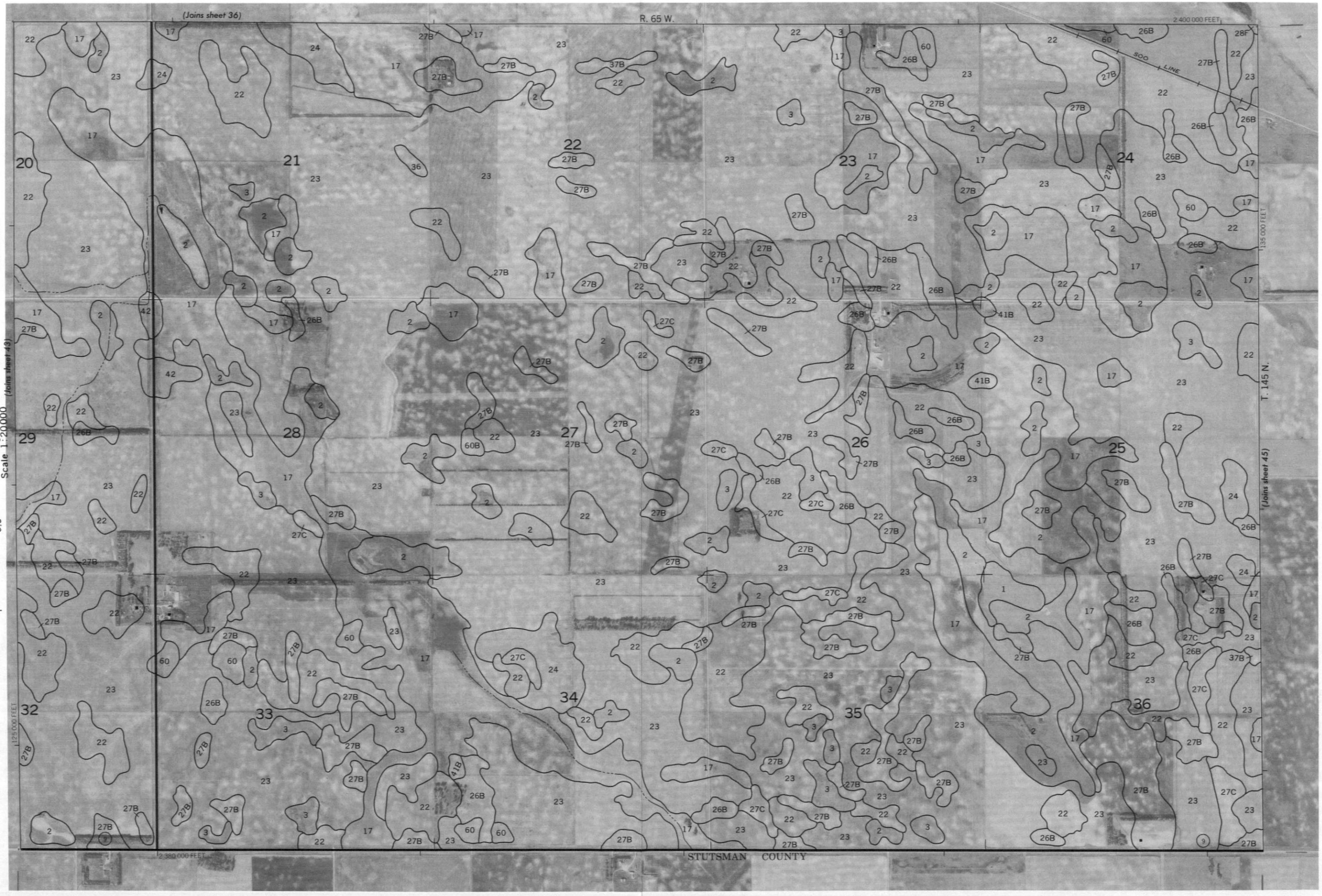
SOIL MAP OF FOSTER COUNTY, NORTH DAKOTA – SHEET NUMBER 42



SOIL MAP OF FOSTER COUNTY, NORTH DAKOTA – SHEET NUMBER 43



SOIL MAP OF FOSTER COUNTY, NORTH DAKOTA – SHEET NUMBER 44



SOIL MAP OF FOSTER COUNTY, NORTH DAKOTA – SHEET NUMBER 45

45

N

1 MILE

1 KILOMETER

Scale 1:20000

0 0.5 1

1/4 1/2 3/4 1

2 405 000 FEET

R. 64 W.

(Joins sheet 37)

DRY LAKE

RIVER JAMES

SOO LINE

ARROWWOOD NATIONAL WILDLIFE REFUGE

T. 145 N.

(Joins sheet 44)

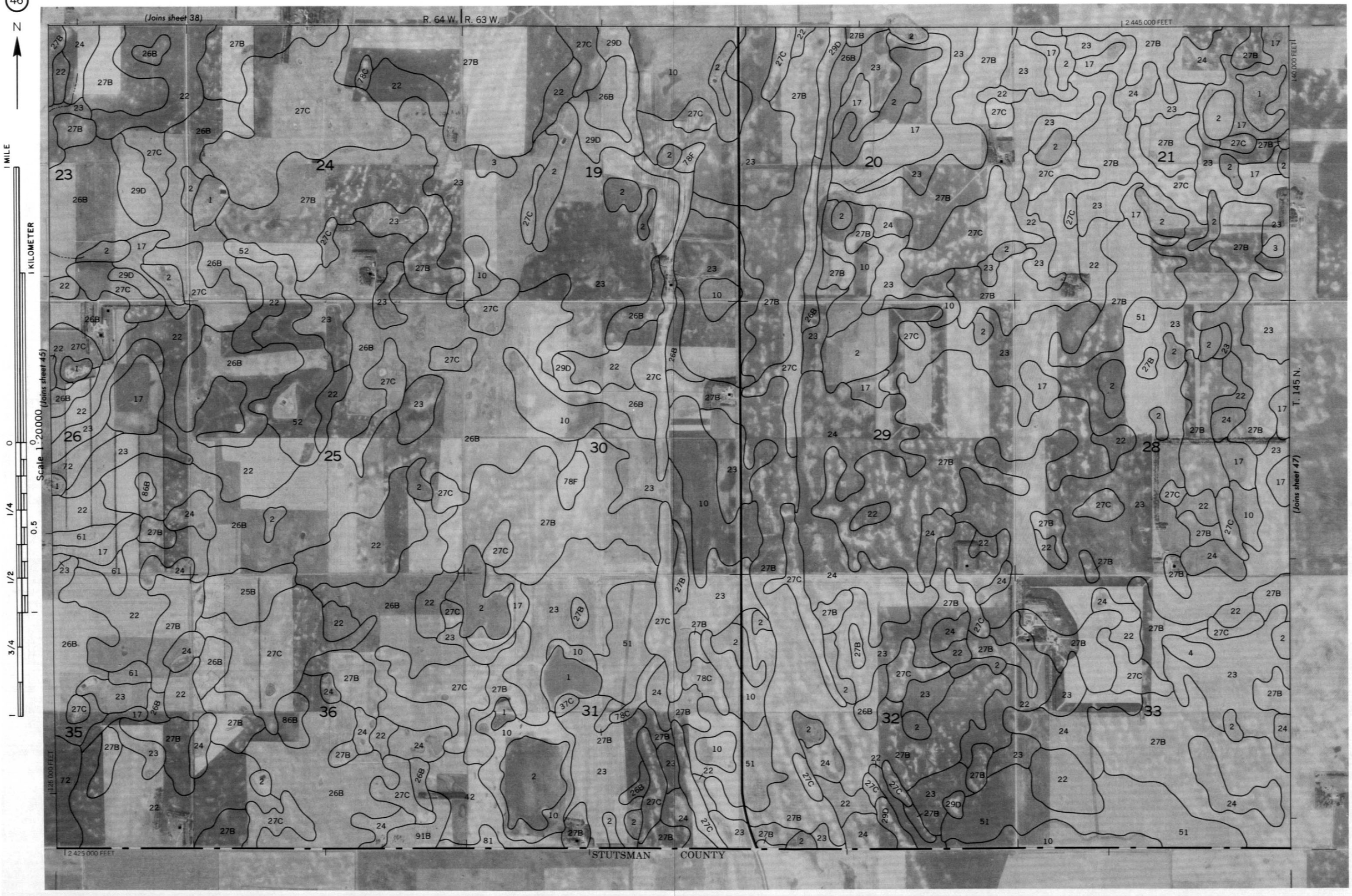
(Joins sheet 46)

135 000 FEET

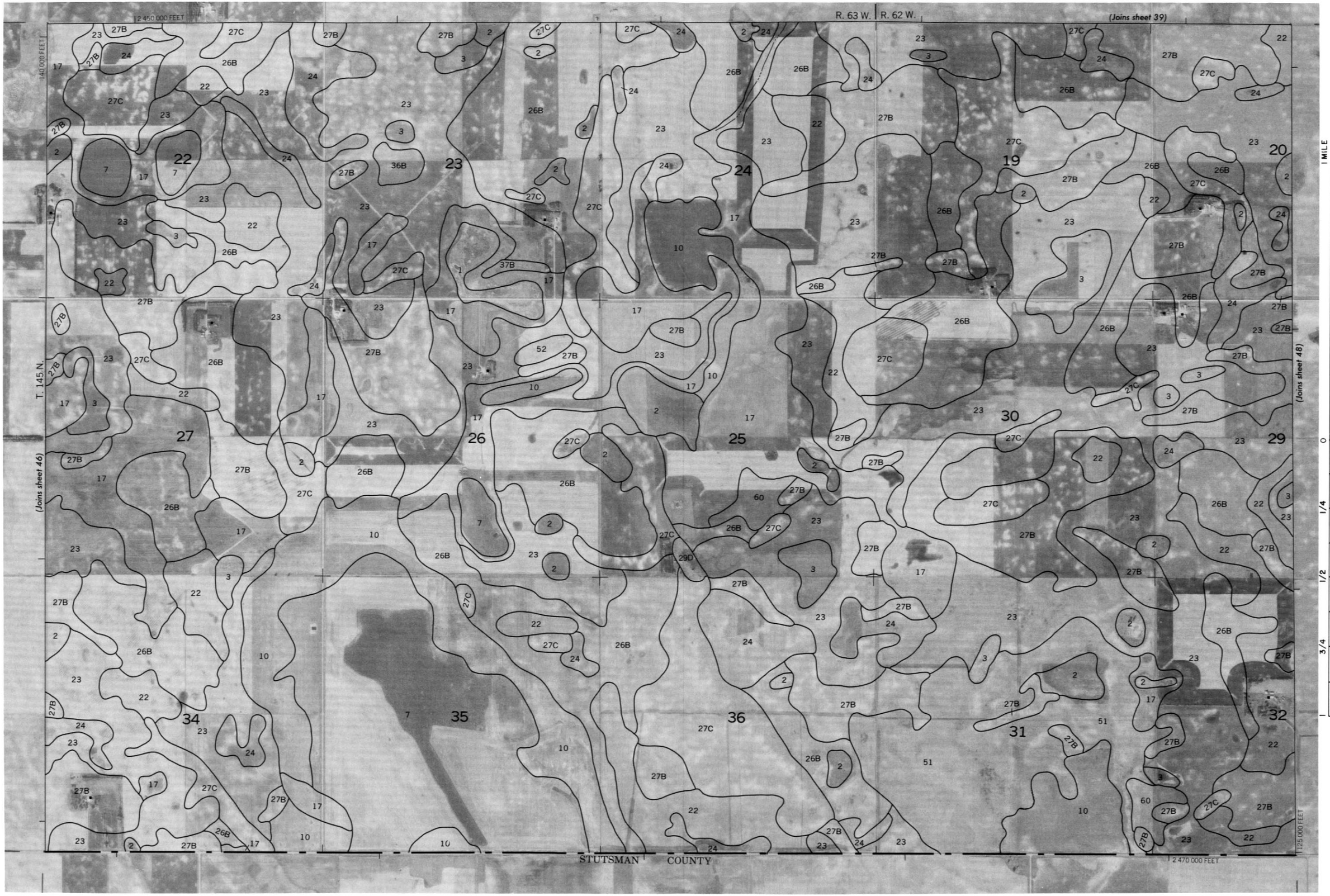
128 000 FEET

2 420 000 FEET

STUTSMAN COUNTY


46
N
(Joins sheet 38)
R. 64 W.
R. 63 W.
2 445 000 FEET
140 000 FEET
T. 145 N.
(Joins sheet 47)
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
0.5
1/2
1
3/4
(Joins sheet 45)
126 000 FEET
2 425 000 FEET
STUTSMAN COUNTY
23
24
19
20
21
26
25
30
29
28
35
36
31
32
33

SOIL MAP OF FOSTER COUNTY, NORTH DAKOTA – SHEET NUMBER 47



47

N

1 MILE

1 KILOMETER

Scale 1:20000

0 1/4 1/2 3/4 1
0 0.5 1

SOIL MAP OF FOSTER COUNTY, NORTH DAKOTA – SHEET NUMBER 48